CSD 5597-93-2

BSM DELTA QUALIFICATION 2 FINAL REPORT

Volume II

11 November 1994

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BSM DELTA QUALIFICATION 2 FINAL REPORT

Volume II

11 November 1994

Submitted to:

USBI Huntsville, AL

Prepared by



432

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FOREWORD

This report, presented in three volumes, provides the results of a two-motor Delta Qualification 2 program conducted in 1993 to certify the following enhancements for incorporation into Booster Separation Motor (BSM) flight hardware:

- Vulcanized-in-place nozzle aft closure insulation
- New iso-static ATJ bulk graphite throat insert material
- Adhesive EA 9394 for bonding the nozzle throat, igniter grain rod/centering insert/igniter case Deletion of the igniter adapter insulator ring
- Deletion of the igniter adapter/igniter case interface RTV
- Deletion of Loctite from igniter retainer plate threads.

The enhancements above directly resulted from (1) the BSM Total Quality Management (TQM) Team initiatives to enhance the BSM producibility, and (2) the necessity to qualify new throat insert and adhesive systems to replace existing materials that will not be available.

Testing was completed at both the component and motor levels. Component testing was accomplished to screen candidate materials (e.g., throat materials, adhesive systems) and to optimize processes (e.g., aft closure insulator vulcanization approach) prior to their incorporation into the test motors. Motor testing — consisting of two motors, randomly selected by USBI's onsite quality personnel from production lot AAY, which were modified to accept the enhancements — were completed to provide the final qualification of the enhancements for incorporation into

This report addresses the motor level test results, with summary discussions of the component level testing where appropriate. Volume I discusses the results obtained from the Delta Qualification 2 testing. Volume II details the environmental testing (vibration and shock) conducted at Marshall Space Flight Center (MSFC) to which the motors were subjected prior to static testing. Volume III provides various supporting documentation to Volumes I and II, including the analyses and plans that governed the testing of the two Delta Qualification units.

BSM MOTOR S/N 1000734 PYROSHOCK TEST PROCEDURE



George C. Marshall Space Flight Center Marshall Space Flight Center. Alabama 35812

BSM-TCP-EP54-001

BSM Delta Qualification Test

Motor to Bracket Assembly / Pyro Shock Simulation Test Procedure

This Procedure Describes Safety Critical Operations

BSM Delta Qualification Test

Motor to Bracket Assembly / Pyro Shock Simulation Test Procedure

Prepared by: Mat Bevill EP-12

08/16/93

Motor SN: 1000734

Test Date: 09/21/93

Motor to Bracket Assembly/Pyro Shock Simulation

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Approved by:	Marin Marin	
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	Rick Clements/MEFC Quality/CQ06	2-45-95 Data
		Date
	Ben Goldberg/Meter Systems Division/EPII	
	Ben Goldberg Meter Systems David	9/14/93 Date
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	Don Weneilusbi	9-11-23
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	- Charles II 1 is	,
	Charlie Lovell/PCH Engineer/CN71	e/10/es
	angneer/CN71	Date

Motor to Bracket Assembly/Pyro Shock Simulation

	0.40.000	CE SIMILISMON
Prepared by:	Mat Beville TE/EP12	<u>09/15/93</u> Date
Approved by:	Jim McGee/MSFC Vibration Lab TE	9/14/93
	Jim Herring/MSFO/Pyro Shock Lab TE	9-14-93 Date
	Richard Leonard/MSFC Safety/CS01	9-16-93 Date
	Rick Clements/MSFC Quality/CQ06	<u>9-15-93</u> Date
	Ben Goldberg/Motor Systems Division/EP11	<u>9//y/9</u> 3 Date
	Steve Brewster/Dynamic Test Branch/ED73	9/14/43 Date
	Chuck Wells/UTC/CSD TE	Date
	Don Wencil/USBI	9-14-93 Date
	Charlie Lovell/PCH Engineer/CN71	Date 9/13

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1.0 General Information

1.1 Scope

This test procedure addresses all the requirements to perform pyro shock testing on Booster Separation Motors (BSM). Included in this procedure are the steps to assemble the BSM to the aft skirt support brackets.

1.2 Objective

The objective of the pyro shock testing is to verify the physical and functional survivability of the Booster Separation Motors. Of particular interest for these tests are the components bonded using EA9394 adhesive. The components using this adhesive include the throat insert, the centering insert, and the igniter grain support rod.

2.0 Applicable Documents

MSFC-STD-513A	Certification of Equipment Operations and Materials Handling Personnel
EG5300.36A	Safety
29 CFR 1910	Occupational Safety and Health Administration (OSHA)
NSS/GO 1740.9	Safety Standard for Lifting Devices and Equipment
NHB 1700.1(V1)	Basic Safety Manual
AMC-R 385-100	Safety Manual
EP01-SOP-01	Standard Operating Procedure for Safety Critical
MM 1700.4	Safety and Environmental Health Hazards
MMI 1700.17	MSFC Procedures for Acquiring Shipping Permits for Rocket Motors and Igniters
MMI 1710.1	Safety Review and Approval of Hazardous and Potentially Hazardous Facilities and Activities at MSFC
MMI 1710.6	MSFC Program for Personnel Certification
MMI 1711.2	Mishap Reporting and Investigation

MMI 1845.1 Hazard Communication Program

MMI 6400.2 Packaging, Handling, and Moving Program Critical

MSFC-RQMT-1493 Electrostatic Discharge Control Requirements

MSFC-STD-1800 Electrostatic Discharge (ESD) Control for Propellant and

MSFC-STD-126E Inspection, Maintenance, Proof Testing and Certification of Handling Equipment

CSD-5597-93-1 Rev. B Enhanced Delta Qualification Test Plan for Booster

Separation Motor (BSM), Aug. 6, 1993

10SPC-0067 Rev. A Specification for Booster Separation Motors for Space

Shuttle Solid Rocket Booster (thru SCN 014)

3.0 Safety

The following safety criteria are in accordance with ET01-SOP-3.1 01, Rev. A., "Standard Operation Procedures for Safety Critical Operations". If safety rules/regulations are not followed, injury to personnel and/or damage to test items could occur.

Emergency telephone numbers are as follows:

Safety 4-0046 Ambulance 112 Fire 117 Security 4-4357 Utilities 4-3919 Medical Center Communication Repair 4-1771 4-2390

- 3.1.1 In the event of serious personnel injury, do not move the injured person unless necessary to prevent further serious injury. Call 112 for ambulance.
- Prior to starting work in 4619 a visual inspection of the work 3.2 area shall be made for anomalies by the MSFC TE and MSFC

Date / Time: 19/21/93 6:00 p. 41.

- 3.3 Personnel shall not work or position themselves beneath suspended loads unless such loads are securely and adequately blocked up.
- Objects handled by overhead hoist shall be lifted only high enough to clear fixed objects in the path of travel. Spreader bars and slings may be left on the hoist if desired when not in use, but must be raised so that the lowest part of the lifting equipment will be at least seven feet from the floor when not in use.
- 3.5 Crane, hoist, prime lift operators, and riggers shall be certified according to the latest revision of MMI 1710.6, and shall have in their possession a valid certification card.

Certifications checked by:

MB

Date / Time:

07/21/93 6.00

- 3.6 Personnel working around suspended loads shall be alert to the possibility of being crushed between the suspended load and a fixed object.
- 3.7 Loads shall be moved slowly so they will not accumulate more momentum than can be stopped with little or no swing.
- Where handling slings are called out, a sling with more pickup points than required may be used if the weight capacity each point of the noted sling and the free pickup point is (are) damage to parts.

 3.9 Only the arrest
- 3.9 Only the area coordinator should direct the crane moves, however, any person determining an immediate danger or problem may request stoppage of activities.
- 3.10 The lifting or transportation operation shall be halted by the area coordinator at any time the control area cannot be maintained.
- 3.11 Steel toe shoes are required during lifting operations. Hardhats are required when the lift is at or above the shoulders.
- 3.12 Tag line operators are to wear leather gloves.

4.21.93

- 3.13 The primary safety hazards associated with this operation are:
 - 3.13.1 Lift operations
 - 3.13.2 Solvent Use (See NOTE)
 - 3.13.3 Live (Loaded) Solid Rocket Motor (propellant handling)

NOTE: Grease and solvent use are only "if needed" as determined by the MSFC TE and CSD TE.

- 3.14 Any time a crane is being used, it must be dogged if:
 - 3.14.1 The load will be suspended in a static condition for an extended amount of time.
- 3.14.2 A crane operator crew change or substitution must be made.
- 3.15 No electric power tools shall be used near the live test item. Use of pneumatic tools is acceptable.
- 3.16 All ground cables and ground straps end-to-end resistances shall be verified with a multimeter. These resistances must measure less than 1 ohm.
- 3.17 All personnel within touching distance of the BSM or ordnance shall wear a wrist strap that has been checked with a wrist strap checker.
- 3.18 All personnel within touching distance of open grain propellant (and ordnance) shall wear antistatic coveralls.
- 3.19 Wrist strap connections to facility ground must be verified. This step should be performed each time the wrist strap ground is broken.
- 3.20 In case of an accidental BSM ignition, the nearest fire alarm pull station shall be activated in order to evacuate building 4619. Personnel shall stay clear of the test site until the emergency response personnel have given the "all clear" to return to the building.

4.0 Test Items and Test Requirements

4.1 Test Items

The test item for the qualification pyro shock tests consists of a live BSM which will be tested in the aft motor configuration. The motor will be tested with an aero heat shield over the exit cone. The motor weighs approximately 154 pounds.

4.2 Test Requirements

Test Tolerances

Unless otherwise stated in this procedure, the tolerances applicable to the test conditions described shall be as specified in MIL-STD-810D. These tolerances are as follows:

Shock Response Spectrum:

(when analyzed with a 1/3 octave shock spectrum analyzer and 5% damping)

4.2.2 Test Data

All data taken with non-recording instruments will be recorded in ink directly onto data sheets and/or log sheets. The log or data sheets will identify the test being performed, the test item, the item part number, and the applicable test procedure. Corrections or changes will be made by drawing a single line through the original entry. The new entry will be made directly above the old and initialed by the person making the entry. Each page will be signed and dated at the bottom of the page by the person making the entries, and counter signed by the test engineer after review.

4.3 Test Conditions

- The pyrotechnic shock tests for both motors will be conducted at the test site's ambient temperature.
- 4.3.1 The MSFC TE shall check with the Army MET team to ensure that (MET team phone number....876-2465).
- If lightning is within 10 miles during any time that a live BSM is in building 4619, the MSFC TE shall make arrangements to disconnect the motor ground from the facility ground. The motor shall remain ungrounded until
- 4.3.1.2 When reconnecting the ground after a lightning storm, a 100Kohm resistor should be connected to the ground wire from the motor before connecting to facility ground. This allows any charge on the motor to slowly dissipate to ground. The resistor should be left connected for no less than 30 seconds.
- 4.3.1.3 After the specified time, disconnect the ground wire from facility ground and remove the resistor. Reconnect the ground strap from the motor to facility ground.

The test site's relative humidity must be above 20%. If the humidity 4.3.2 is below 20%, all test operations must cease until favorable weather

[X]

Test site's relative humidity 52% MSFC TE MSFC TE 100 9/2/43

- Test Equipment 4.4
- All measurements shall be made with instruments and equipment whose accuracy and/or calibration has been

Calibration Acceptable_ (MFSC TE)

- 4.4.2 Proof Loading of Handling Equipment (required for PCH)
- The heaviest lift during all of the delta qualification testing 4.4.2.1 will be lifting the motor while in its shipping container. The motor and shipping container together weigh about 310 lbs. All forklifts and overhead hoists must be load (break) tested to at least 110% of this weight (i.e. 350 lbs.). This test must be performed prior to any handling of the BSM but does not need to be repeated until something other than the BSM is lifted by the same handling equipment. It is therefore recommended that the break tests be performed each evening before the BSM testing commences. The break tests shall be performed as follows:
 - The proof load must be at least 350 lbs. a.
 - Lift the dummy load clear of the ground (less than 1 foot) and lower to ground three times, holding for five minutes on the third lift. Lifting straps and spreader bar should be attached

SEE APPENDIX E FOR THE PROOF TEST INSPECTION SHEETS.

- 4.5 **Test Procedure**
- After review and documented approval, a redline change to this procedure may be performed. Approval shall be by a minimum of MSFC TE, MSFC SE, and the MSFC QA.
- As soon as possible after a test failure, a deviation from the specified test environment, or any other incident which affects the test or test item, MSFC will notify the authorized UT/CSD representative of the event verbally and will then generate a Test Procedure Deviation (NASA form 3959). A copy of the Test



Procedure Deviation is presented in Appendix B. Photographs of any discrepancies shall also be taken.

5.0 Personnel Responsibilities

5.1 Test Witnessing

All tests will be witnessed by the authorized UT/CSD representative and USBI representative. The MSFC test engineer will also witness the testing. Notification of the start of each test shall be communicated to the authorized UT/CSD and USBI representatives and the MSFC safety representative and test engineer at least 2 hours in advance.

	MSFC Safety Notified
	UT/CSD Notified
5.	The MSFC TE will serve as the area coordinator for the test. All handling of the BSM will be directed by the MSFC TE or cognizant test engineer.
5.3	Jim Herring (pyro shock) shall be responsible for photographic coverage of the pyro shock tost
5.4	secured before the live BSM is brought to the pyroshock facility shall be
	Area secured? YES NO MSFC TE
	Comments: Doors locked gates secured.
5.5	The MSFC TE shall notify the fire department prior to delivery of the BSM. (Fire dept. phone #117).
5.6	The MSFC TE shall make arrangements for the live BSM to be delivered from the NASA igloo to the pyro shock test site. All involved lab dimental arrangements for the live BSM to be with the live BSM to be all involved lab dimental arrangements for the live BSM to be delivered from the NASA igloo to the pyro shock test site.
5.7	All involved lab directors and division chiefs shall be notified [-]



6.0 Pyrotechnic Shock Test

6.1 Test Site Preparatory Activities

An inspection shall be made of the hardware to ensure it is all available. Should some hardware be missing the cognizant test engineer shall determine whether those components are required for the safe operation of the procedure. Should they not be required for safe operations, the test engineer shall determine whether an operations halt is required or whether the operations may proceed.

6.1.1 Verify the following components, tools and materials are available and certified (when applicable). All lifting equipment, cables, fixtures, etc... within one year stating the load limit and the date tested stencilled on the equipment.

[4

Aft BSM Plate Mounting Hardware:

Part Number EWB0420-8-23 EWB0420 - 10-(20,-32) TLN1021CPD2-8 TLN1023CD3-10 NAS1587-8C NAS1587-10C	Quantity 6 2 6 2 6 2 6 2	Nomenclature Bolts* Bolts* Nut (SelfAligning) Nut (SelfAligning) Washer Washer
---	--------------------------	--

^{* 10107-}XX-XX series bolts are acceptable alternates (-20 for pvro. -32 for vibration)

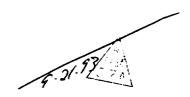
Aft BSM Bracket Mounting Hardware:

_		a wate,
Part Number NAS1955C10H NAS1957C13 NAS1587-5C NAS1587-7C NAS1587-7 VN324BC070	Quantity 8 12 8 12 12 12	Nomenclature Bolts Bolts Washers Washers Washers Locknuts
NAS1101E08H10	14	Aero Heat Shield Fasteners
Fasten	ers Accounted For:	MB MSEC TE

Fasteners Accounted For: MSFC TE
Breakover brackets 2
Lifting D-rings

9.21-13

Spreader bar with associated lifting straps and D-rings	/
Custom wood supports to horizontally support the BSM	lu
Tool Box with Assorted Wrenches Rm 170, Bldg. 4619 (See Appendix D for detailed tool list)	[4]
Pre-drilled Wood Pallet to fit aft skirt support bracket bolt holes	[y]
Lifting straps (3)	/
SN: 3298 SN: 3701 SN: 3203	W
Desiccant (12, 16 unit size bags)	C.3/
Rubber mallet	14
Lead wire seal (for security bag)	LY MA
Forklift (at least 500 lb. capacity)	41
ESD Scanner	14
Materials	14
1,1,1 Trichloroethane; 1 bottle (enough for cleaning)	[14]
MIL-G-4343 grease; 1 container (AHS seal)	[3]
MIL-T-83483 thread compound; 1 container (AHS)	id
Conoco HD-2 grease; 1 container (bolts, faying surfaces)	14
Other consumables, including rimple cloth, que-tips, tape, bags and towels are also to be supplied if needed.	
Gloves (Latex) Ground straps Wrist stats (5 each) Stat gun (1 each) Ohm meter (1 each) Wrist stat checker (1 each) Chemical safety goggles (2 each) 100 Kohm resistor (1 each)	IT IT IT IN A



All hardware accounted for: B all needed for MSFC TE	
6.1.2 After the truck has arrived with the motor, the engine should be the truck's wheels. MSFC TE MSFC TE turned off and the emergency brake engaged. Chock at least one o	f M
Truck braked and wheel chocked:	
6.1.3 A sign with the word "LOADED" should be attached to the motor shipping container.	[Q
6.1.4 Attach a ground strap (long enough to reach the shipping container on the truck) to the pyro facility ground and verify the resistance. Resistance must be less than 1 ohm.	[4]
Resistance measured: 0.2.1 MSFC QA OF	
CAUTION: Make New Ground Before Braking Old Ground.	
sure the truck and the facility are at the same potential, then, container (not to lid or lid bolts).	[1]
6.1.6 Check continuity of shipping container to ground strap using an ohm meter. Resistance should measure less than 1 ohm.	IJ
MSECON MORECON	
Move tie down out of the way.	M
6.1.8 Disconnect shipping container to truck chassis ground.	
removing from the truck.	M
Using the fork lift, remove shipping container from truck and set container on the floor in the test room where it may be easily by the MSFC TE, the overhead crane may be used to remove the shipping container from the truck.	W
Forklift used: yes no Crane used: was	
The truck may exit the test area at this time.	_
NOTE: If the truck does not leave the site at this time, the driver will coordinate the exit with the MSFC TE.	[4]

F.21-13/

6.1.11	The large pyro bay doors should be "closed in" but left "cracked" open during the assembly and pyro test operations.	Ŋ
6.1.12	Install the shock test control equipment on the pyro plate as illustrated in Figure 1 (see Appendix C).	W
	Equipment installedMSFC TE	
6.1.13	The pyrotechnic shock test will be conducted in the aft motor configuration.	[1]
6.2	Pyro Test Setup	
o	Record the test site's temperature and relative humidity. The relative numidity shall be above 20%. If the humidity is not above 20%, all test operations must halt until favorable weather conditions resume.	[4]
7	Temperature:% °F; Relative Humidity%	
	Remove Motor From Shipping Container	
6.2.1.0	Verify wrist straps are being used by ALL personnel while working with the live motor. All wrist straps shall be checked with a wrist strap checker before being used. Continuity checks shall be performed on all main ground straps after making any new ground connection. MSFC SE	[3
6.2.1.1	Position shipping container so that the overhead crane can easily attach to the test item (this step necessary only if fork lift positioning was not adequate for crane attachment.)	[4]
CA	UTION: When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.	
	After initial reading over 1.0 kilovolt, repeat electrost: reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations a continue.	

4.21.

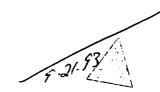
If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety, and evacuate all personnel to safe locations as directed by safety.

WARNING: Do not remove the nozzle's security bag and weather seal. Removing the bag and seal will expose the propellant grain and increase the risk of motor

6.2.1.2 Open the chiral

00-		
6.2.1	interferes with the removal of the test item. Monitor static	[4
	Record Stat Gun reading Orith Stabilized	
	necord SN of Stat Gun C10659	
6010	CAUTION: Make New Ground Before Produc	
6.2.1.3	Attach a count	
	region a ground wire to the pure facility	
	resistance. Resistance shall by a lacility ground and work	_
	Attach a ground wire to the pyro facility ground and verify its wire should be attached at a location close to the BSM. Resistance Translation of the BSM.	ru/
	This	()
	Positive to the BSM	
	Resistance measured OIN MSFC QA R	
00.	MSFC QA Pr	
6.2.1.4	Attach the	
	Attach the ground wire in step 6.2.1.3 from the facility ground to the live BSM.	
	to the five BSM	
	and facility ground	t. 1/
6.2.1.5	Disconnect the motor to shipping container ground wire. Attach two liftings	(G
	Disconnect the motor to shipping	
6010	ampping container ground	
6.2.1.6	Attach two lies: .	Ų′
	off south and rings (along with the	Y
	aft section, 180° apart.	
601=		y/
6.2.1.7	Certifications can appear	4
	for all lifting fixtures at the	
	Certifications for all lifting fixtures shall be provided:	
	Lifting beam assombly	7
	Lifting beam assembly certification provided MS	.1
	Lifting rings (D-rings) MB	



CAUTION: When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and

After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may

If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety, and evacuate all personnel to safe locations

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load. 6.2.1.8

6.2.1.8	Slowly, monitoring static charge, lift the motor out of the container using the overhead crane. Lower the test item so that the forward end of the motor is at waist height.
	A detailed visual inspection shall be performed by the MSF

test engineer and the CSD test engineer on the live test items before testing. Record the motor's serial number.

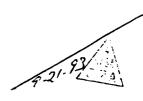
No damage MB No Damage Damage (detail in attachment) Serial Number 1000734

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

6.2.1.9 Attach the "break-over" brackets and lifting strap on the forward end of the motor (see Figure 2, Appendix C).

14

CAUTION: Do Not disconnect the ground wire while breaking the motor to the horizontal position.



CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

6.2.1.10 Lower the motor on its wood supports so that the motor rests horizontally. The MSFC TE will designate someone to hold the lifting strap on the forward end while placing the motor in the horizontal position (see Figure 3, Appendix C). The person holding the strap should be wearing a wrist strap.

[4/

6.2.1.11 Unhook the lifting straps and remove lifting hardware.

W

6.2.1.12 Re-attach the lifting hardware for bracket installation. Attach lifting straps in the saddle position (see Figure 4b, Appendix C).

1

6.2.2 Attach Motor to the Aft Skirt Support Brackets

Steps 6.2.2.1 and 6.2.2.2 may be skipped if deemed "not necessary" by the MSFC test engineer and the CSD test engineer. However, the fasteners should still be installed with grease applied. If time permits, all of the cleaning and surface preparation may be done *before* the test date.

CAUTION: When using trichloroethane, personnel shall wear chemical goggles and neoprene-Latex gloves.

Contaminated materials shall be disposed of as hazardous waste.

CAUTION: When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

6.2.2.1 Wipe faying surfaces clean with 1,1,1 trichloroethane and apply an unbroken film of HD-2 to each surface.

After assembly remove excess grease with a lint-free cloth.

[4

CAUTION: When using trichloroethane, personnel shall wear chemical goggles and neoprene-Latex gloves.

Contaminated materials shall be disposed of as hazardous waste.

CAUTION: When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

4.21.93

6	Clean washers and bolts with 1,1,1 trichloroethane and install wet with HD-2 grease. After assembly remove excess Washers else.
	Washers cleaned at this time: Yes No
	CAUTION: Make sure the motor remains properly grounded during the move to position the test item
	during the motor remains properly grounded 2.3 Position the motor remains properly grounded
6.2	Position the material
	2.3 Position the motor on the wood supports so the forward and aft brackets can be easily attached. Leave lifting strange attached.
62	brackets can be easily attached. Leave lifting straps attached. 2.4 At forward end of PCAS:
0.2.	2.4 At forward end of BSM install NAS1955C10H bolts with threaded inserts (8 places) through support
	NAS1587-5C washers (8 places) through supports and into
	threaded inserts of BSM and torque to 145 to 170 in-lbs (13 to
	To the loss of the
	Torque value: 160 19-16; MSFC QA
	Record SN of the same of the s
	Record SN of torque wrench: $7 - 247 - 62 (+671)$
	The forward and a
	NOTE: The forward attach bracket has an alignment pin so there is only one way it can be installed.
	NOTE: Be sure the state of the
	with the forward bracket is in correct alignment attach bracket before installing the aft
6.2.2.5	At aft end of DCAr
	washers (under bolt head), NAS1587-7 washers (under nut) and (39 to 45 ft-lbs) above at 2 places) and torque to 460 to 540 in
finning Torget	Washers (under bolt head), NAS1587-7 washers (under nut) and VN324BC070 locknuts (12 places) and torque to 460 to 540 in-lbs (39 to 45 ft-lbs) above running torque. * Dus To watce-554Billing Bolts were Torque value: 550 in-lb MSFC QA Record SN of torque wrench: 1-267-162 (4-671) (in-lb) Bracket Cover Installation Bracket cover Installation
Sim In Cacti	(39 to 45 ft-lbs) above running torque * Page 7460 to 540 in-lbs
112190	Torque value: 500 Torque value
5/N 6313	MSFC QA
	Record SN of torque wrench: T-2/7
6.2.3	Record SN of torque wrench: T-267-102 (4-671) (in -16) Bracket Cover Installation Bracket cover required? W
• • •	Cft 16) Put 121
6.2.3.1	Stacket cover required? YesNo
	If yes above, the 1/4 inch diameter bolts shall be torqued to diameter bolts above running torque. The 5/10 inch
	90-110 inch-pounds above running the shall be torqued to
	90-110 inch-pounds above running torque. The 5/16 inch diameter bolts shall be torqued to 185-200 inch-pounds (16 to 17 ft-lbs)
	Torque value: MSFC QA
	Record SNI - C.
	Record SN of torque wrench:

4-21-13/

PAS 121-13
PC 1/21-23
PC 1/21/43

Motor 90 Degrees for Pyro Plate Mounting

•	Tace fasteners in a labeled bag.	[]
~ ₽	ith the test item resting on the brackets, unhook the belly straps is the horizontal stabilizing bar (lifting straps should still be in be choked position as shown in Figure 4a. Appendix C)	[]

Wrap the belly straps around the motor on each end as shown in [] Figure 4b (saddle configuration, Appendix C).

Personnel shall not work under or place any body part under a suspended load.

Be careful not to disconnect the motor's ground wire during the lifting and rotation operation.

Lift the motor and brackets to waist height using the overhead crane so that the motor can be rotated.

U

Holding the motor by the support brackets, rotate the motor 90 degrees so that the brackets can be mounted on the pyro plate.

Use the overhead crane to move the test item to the mounting area on the pyro plate.

trach the Brackets and Shims to the Pyro Plate

Be sure to put the custom shims in their correct positions and orientation before sliding bolts through the pyro plate.

CAUTION: When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

Install wet with grease (HD-2) EWB0420-8-23 bolts (10107-8-23 alternate) with NAS1587-8C washers and TLN1021CPD2-8 self-aligning nuts at "A", "B", and "D" positions (as marked on supports, 6 places) and torque to 605 to 710 in-lbs above running torque. At the "C" position, install EWB0420-10-20 bolts (10107-10-20 alternate) with NAS1587-10C washers and TLN1023CD3-10 self-aligning nuts (2 places) and torque to 1175 to 1380 in-lbs above running torque.

CERCULAL PAGE IS

6151

9-21-97/

Redline:

Aero Heut shield holes on the motor exit cone had to be tapped for Aero Heut shield assembly. This step was performed before the grain inspection.

-	Record SN of torque wrench: 6" EMJ00359 A,B,D BTW-2RCE			
6.2.5.2	Release the tension from the lifting straps but do not disconnect the straps. These straps may be used to tape off accelerometer wires if necessary.			
6.2.5.3	Place the pyrotechnic debris shield in front of the large bay doors on the north side of the pyro room.			
6.2.6	Perform Grain Inspection			
6.2.6.1	Clear area of all nonessential personnel for grain inspection. (Only the grain inspectors (2) and the MSFC TE shall remain.)			
6.2.6.2	Verify grain inspector(s) is(are):			
	a. Wearing 100% cotton coveralls, shorts, and undershirts.			
	b. Wearing a wrist strap.			
	c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.			
6.2.6.3	The grain inspector shall now remove the security bag and cover from the exit cone.			
6.2.6.4	Perform grain inspection.			
	Cracked propellant? yes			
If was, give approximate location and size of crack. No propellant arain exacts or other defects noted Small amount of ETV residue on ignifer case and main grain. Ok to proceed with pyroshock Other comments on grain condition:				
Grain inspector J. Blantons 9-21-93 62.7 Install Aero Hoot Chiefeld				
The state of the autometer				
CAU	TION: When using trichloroethane, personnel shall wear chemical goggles and Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.			

4.21-93

6.2.7.1	using a	(if necessa lint-free clo e identificat		e or oil from the ichloroethane.	aeroheat shield DO NOT clean	14
	Cleanin	g performe	d: Yes	No		
C	AUTION:	chemical Contami		ethane,person neoprene-Lat als shall be di	nel shall wear ex gloves. sposed of as	
C	AUTION:	When using grease, personnel shall wear Neoprene- Latex gloves. Contaminated materials shall be disposed of as hazardous waste.				
1	NOTE:	Dow Corn meets the	ning Moly Ko e MIL-G4343 s	te 55M Silicon pecification.	e O-ring lubric	ant
6.2.7.2						
	Surface of Surface le	leaned: ubricated:	YesN YesN	0		
CA			ng grease, per ves. Contami of as hazardo		vear neoprene- ls shall be	
6.2.7.3		E seal, P/N ; results of th IIL-G-4343	IM DIVEN SENDED AS	or damage that c vibration tests.	ould	M
	Seal dama	aged?	yes	ng		
	Decription	of damage: _				
] 8	Fig. 5, App and the sm	endix C). The	e large up on e larger lip is d de seal outside		l. ∍,
6.2.7.4	INSTALL		2879-02-01 05 4	he exit cone of t		W

4.21.83

CAUTION: When using thread compound, personnel shall wear neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

6.2.7.5 COAT fourteen (14) screws (NAS1101E08H10) with MIL-T-83483 thread compound.

CAUTION: When installing the Aero Heat Shield, personnel shall be extremely careful not to drop any foreign object into the rocket motor (watches, rings, and other jewelry shall be removed; eye glasses shall be tethered if worn).

With the nozzle cant vertically up, a properly grounded operator 6.2.7.6 will INSTALL the aeroheat shield cover with the hinge on the left or right side when aft looking forward as specified by USBI/CSD. Proper alignment in either position is provided by a positioning pin and mating hole.

(NOTE: DO NOT lockwire the screws.) & screw were exertically lockwired to perent fasteness falling out as they do in the other nature son socio? 38.

INSTALL the 14 screws and TOPOLIE 11.

6.2.7.7 INSTALL the 14 screws and TORQUE the fasteners using a standard cross pattern. Record the torque values.

First Pass: Finger Tight MSFC QA Second Pass: 10-15 in-lbs Value: _/U -/5 MSFC QA Third Pass: 20-25 in-lbs Value: 20-25 MSFC QA Fourth Pass: 20-25 in-lbs Value: <u>20 - 2</u> MSFC QA

Record SN of torque wrench:

Make Sure the Pyro Facility Bay Doors are Open 6.2.9 Clear Area for Test

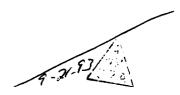
The only personnel allowed in the control room are the pyro shock test conductor, a pyro technician, the MSFC TE, and the MSFC SE (total of four (4) people). All other personnel should move to a clear area. The clear areas are defined as the NORTH

hallway of building 4619 and the area outside the pyro control room on the WEST side. Other areas must be cleared with the MSFC TE

6.2.9.0 Conduct Pyro Shock Test to the Following Parameters:

Test Parameters:

	Frequency (Hz)	Level
	100 +12 d 100 to 4000 94 4000 to 10 000 +6 di	g peak lb/octave g peak b/octave g peak
6.2.9.	1 Turn on the flashing light outside room 1	704
6.2.9.2	For each measurement location select an suitable for the amplitude expected.	accelerometer of a type
6.2.9.3		K-FOP-008
6.2.9.4	Verify test, checkout, and assembly hardward facility ground system.	are are connected to the
6.2.9.5	Verify that no leads are connected to the ju	Inction has to the
6.2.9.6	Move junction box switch to "BULB" position	• •
6.2.9.7	Connect 12 volts to the firing panel.	19
6.2.9.8	Insert the firing key and verify panel meter correct voltage.	indicates the
6.2.9.9	Switch key to "ARMED" position and verify light is illuminated.	
6.2.9.10	Open red cover and flip firing switch, verify box lights.	
6.2.9.11	Close red cover.	
6.2.9.12	Switch key to "SAFE" position.	M
6.2.9.13	Move junction box switch to "METER" posit	ion [Y]
6.2.9.14	Switch key to "ARMED" position and verify light is illuminated.	power indicator
6.2.9.15	Open red cover and flip the firing switch, ver on junction box indicates 12 volts.	rify that the meter



6	3.2.9.16 Close red cover.	
6.		M
6.	3.2.9.17 Switch key to "SAFE" position and disconnect voltage source. 3.2.9.18 Remove firing key.	M
	2.9.19 Verify that no severe weather or electrical storms are within	[4]
6.2	2.9.20 Verify that no flammable solvents, paints, gases, etc., are	
6.2.	19.21 Verify all non-essential personnel are clear of the test area.	[٠]
6.2.	-5 Pyro technician is:	W
	a. Wearing 100% cotton coveralls, shorts, and undershirts.	N
	strap when installing explosive items	
	c. In possession of the arming key and that the firing panel is in the safe position.	
6.2.9. <u>9</u>	The pyro technician shall remove all matches, lighters, jewelry, and all battery-powered devices such as electrical wrist watches, calculators, portable radios, etc.	Ŋ
	a maximum of two people (to be designated by the MSFC TE)	M
6.2.9.25 6.2.9.26	of ~25 grains per foot) (See Fig. 6 and Fig. 7. A	M
	on junction box is in "RIU D"	r. x
	the area to possibly cause detonation of the blastin cap. The cap should be left shorted and returned to room 170B storage cabinet. All blasting activities	i ig io
6.2.9.27	on junction box is not illuminated	
6.2.9.28	In room 170B, verify that blasting cap shorting coil is in place and is undamaged before removing from storage container. Remove blasting and 6	M
6.2.9.29	Remove blasting cap from container and transport to room 170.	W

4.21-97

	6.2.9.30	In room 170, verify that wrist straps are in place.	,
(6.2.9.31	Install blasting cap on exciter plate.	M
•	5.2.9.32	Press blasting cap shorting coil firmly against facility ground for 1 second. In order to short the leads, remove enough short coil from the blasting cap to attach alligator clip.	W W
6	.2.9.34	Remove shorting coil.	ing
6.		Move switch on junction box to "METER" position.	M
6.2	2.9.36	Verify 0 (zero) volts on meter.	[Y]
	WAR	NING: If voltage is indicated, the lines to the firing pa are either connected to a voltage source or are picking up voltage from radiation caused by a source. The cap should be left shorted and ret to room 170B storage cabinet. All blasting activ	nel nearby
6.2.	9.37 M	love junction box switch to "BULB" position.	loved.
6.2.9	"F	stall blasting cap leads in junction box, move switch to IRE" position, and remove alligator clip	14
6.2.9	an	e pyro technician shall now leave the area, close the door,	M
6.3	Detor	nation of Pyrotechnics	-
6.3.1	The leasystem	ad pyro engineer shall now prepare the data acquisition	14
6.3.2	Start tl	he tape recorder.	
		t firing lines to the pyro control room junction box.	M
6.3.4	The lead the MSI the clea	d pyro engineer, the pyro technician, the MSFC TE, and FC SE shall now leave the pyro control room and move to rarea outside.	M
6.3.5 (Connect verify th	firing panel voltage supply and insert firing key,	19/
6.3.6 E	Begin co	untdown.	19
			[9]



6.3.7	On the count of "3", the pyro technician shall put the switch is illuminated.	ī. /
6.3.8	On the FIRE command, the pyro technician will open the red	<i>(</i> 1
6.3.9	position.	W
W	ARNING: If blasting cap does not fire, refer to Section 10.4	[y
	Blasting Con Di	
6.3.10	Blasting Cap Fired: yes no	
6.3.11	Remove the arming key and disconnect the voltage supply. Test personnel may now return to the control room. Wait a minimum as a	M
6.3.12	Wait a minimum of 5 minutes after firing before opening	[1]
6.3.13	The lead pyro engineer shall	[4]
6.4 Po	The lead pyro engineer shall now begin to reduce the data. st Test Inspection	M
6.4.1 Info	orm the MSFC TF that the door to room 170 from the control is to be opened.	
box	pyro technician shall enter room 170 and move the junction	[1]
orro nem	ove blasting cap leads com.	[Y
6.4.4 Inspe prope	ect the shock plate to insure all explosive devices fired	M
WARN	ING: If all arms.	
O'S'O THE R	SM chall 1 (See Annon dia 4)	
ពលជា វ	nnel shall remain in the control room or in the clear area	[1/
MDFC.	TE indicates all clear for approximately	
6.5 Post To	est Removal from the Pyro Plate	**

9.21.53

6.5.1		ified fork lift (500 pound minimum) ready to load the callet onto the transport truck.	N
	CAUTION:	Exercise care not to entangle or tug on the motor grounding strap during the following lifting operations.	•
6.5.2	Tighten the the bolts car	lifting straps using the overhead crane so that n be loosened.	M
6.5.3	De-torque a to the pyro p	nd remove the bolts that attach the brackets plate.	M
	CAUTION:	The following steps involve working with a suspeload. Keep hands and feet out from under the lo	ended ad.
6.5.4	Remove cus vibration tes	tom shims and place in labeled bag for use in the sts.	W
6.5.5	Lower the n	notor to waist height.	W
6.5.6	Rotate the n	notor 90 degrees so that the brackets can be mounted t. placed on floor, MB calcular (granted mat) RC 9-21-93 RW 9-21-93	W
6.5.7	Using the oving the second the se	verhead crane, place the motor on the pallet so that he aft skirt support brackets and is aligned with the	W
6.5.8	With the tes straps from	t item resting on the brackets, unhook the belly the horizontal stabilizing bar.	[1]
6.5.9	Bolt the test transport to	item to the pallet using the provided fasteners for vibration.	[]
	Motor secu	red to pallet OH MSFC TE	
6.6	Test Repor	t and Data Requirements	
	testing is con will be subm Q=10 value)	report will be submitted to UT/CSD within 30 working day mpleted. Three copies plus one reproducible copy of this nitted containing shock response spectrum (SRS) plots (w and the time history plots. The test tolerances shall be on the control spectrum.	report
	equipment s	pers and serial numbers for all instrumentation and test hall be included in the report. Test setup photos should ded in the report.	

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7.0 Post Test Verification

The procedure delineated in the above document has been satisfactorily completed and :

- a. All sequences in the procedure have been completed (or deleted by approved deviation)
- b. All Procedure changes have been recorded and approved.

Submitted Verified by:	Mat Bevill
,	Test Engineer

Date: $\frac{09/21/93}{1000734}$ Motor Serial Number: $\frac{1000734}{1000734}$

9-21-93

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BSM MOTOR S/N 1000734 VIBRATION TEST PROCEDURE



George C. Marshall Space Flight Center Marshall Space Flight Center. Alabama 35812

BSM-TCP-EP54-003

BSM Delta Qualification Test

Vibration Tests and Packaging Procedure

This Procedure Describes Safety Critical Operations

BSM Delta Qualification Test

Vibration Tests and Packaging Procedure

Prepared by: Mat Bevill EP-12

08/16/93

Motor SN:
Test Date:

Vibration Tests and Packaging Procedure

and Packaging Procedure	
Mat Bewill	
A	09/15/93 Date
Jim McGoe/MSFC Vibration Lab TE	9-14-93 Date
	9-14-93 Data
Kalay Lean	9-16-93 Date
	Date 2-15-93 Date
	•
Section Systems Division/EP11	9/14/93 Data
Clarke 5. Wells	9/4/98 Bate
Souples Lucil	9/15/93 Date
Don Wenel/USBI	9-14-23 Date
Charlie Lovell/PCH Engineer/CN71	9/16/83 Date
	Mat Bevill/MSFC TE/EP12 Jim McGee/MSFC Vibration Lab TE Jim McGee/MSFC Vibration Lab TE Jim Herring/MSFC Syre Sheek Lab TE Richard Leonard/MSFC Safety/CS01 Rick Clements/MSFC Quality/CQ06 Ben Goldberg/Motor Systems Division/EP11 Steve Sreyster/Lynamic Test Branch/ED73 Clube Sulla Chuck Wells/UTC/CSD TE

Vibration Tests and Packaging Procedure

Prepared by:	Mat Bevill/MSFC TE/EP12	09/15/93 Date
Approved by:	Jim McGee/MSFC Vibration Lab TE	9-14-93 Date
	Jim Herring/MSFC Pyto Shock Lab TE	9-14-93 Date
	Richard Leonard/MSFC Safety/CS01	9-16-23 Date
	Rick Clements/MSFC Quality/CQ06	9-15-93 Date
	Ben Goldberg/Motor Systems Division/EP11	9/14/93 Date
	Steve Brewster/Dynamic Test Branch/ED73	9/14/93 Bate/
	Chuck Wells/UTC/CSD TE	Date
	Don Wencil/USBI	9-14-95 Date
	Charlie Lovell/PCH Engineer/CN71	9/16/93 Date

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5	.0	Personnel Responsibilities
6.		Vibration Tests
7.0	66.6.6.6.6.6.6.6.7.1.7.2.7.3.7.4.7.5	Tangential Axis Tests Axis Change from Tangential to Longitudinal Longitudinal Axis Test Post Test Inspection Data Requirements Conditioning Chamber Removal Aero Heat Shield Removal Post Test Inspection of Motor Grain Adapter Plate Removal Aft Skirt Bracket Removal
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9.0	Plac	ce Motor in Shipping Container
10.0	Test	Report
11.0	Post	Test Verification
	Appe	endix A - Notice of Deviations endix B - Figures endix C - Proof Test Inspection Sheets (lifting equipment)

1.0 General Information

1.1 Scope

This test procedure addresses all the requirements to perform vibration testing on Booster Separation Motors (BSM). The test vehicle dynamics vibration.

1.2 Objective

The objective of the dynamic testing is to verify the physical and functional survivability of the Booster Separation Motors. Of particular interest for these tests are the components bonded using EA9394 adhesive. The components using this adhesive include the throat insert, the centering insert, and the igniter grain support rod.

20 Applicable Documents

MSFC-STD-513A	
EG5300.36A	Materials Handling Personnel Safety
29 CFR 1910	Occupational Safety and Health Administration
NSS/GO 1740.9	Safety Standard Co. T. C.
NHB 1700.1(V1)	Safety Standard for Lifting Devices and Equipment Basic Safety Manual
AMC-R 385-100	Safety Manual
EP01-SOP-01	Standard Operating Procedure for Safety Critical
MM 1700.4	Safety and F
MMI 1700.17	Safety and Environmental Health Hazards MSFC Procedures for Association
MMI 1710.1	MSFC Procedures for Acquiring Shipping Permits for Rocket Motors and Igniters Safety Review and Associated States
MMI 1710.6	Safety Review and Approval of Hazardous and Potentially Hazardous Facilities and Activities at MSFC MSFC Program 6
MMI 1711.2	MSFC Program for Personnel Certification Mishap Reporting and Investigation

MMI 1845.1	Hazard C.
MMI 6400.2	Hazard Communication Program

Packaging, Handling, and Moving Program Critical Hardware

MSFC-RQMT-1493 Electrostatic Discharge Control Requirements

MSFC-STD-1800 Electrostatic Discharge (ESD) Control for Propellant and MSFC-STD-126E

Inspection, Maintenance, Proof Testing and Certification CSD-5597-93-1 Rev. B

Enhanced Delta Qualification Test Plan for Booster Separation Motor (BSM), Aug. 6, 1993 10SPC-0067 Rev. A

Specification for Booster Separation Motors for Space Shuttle Solid Rocket Booster (thru SCN 014) Safety

3.0

The following safety criteria are in accordance with ET01-SOP-3.1 01, Rev. A., Standard Operation Procedures for Safety Critical Operations". If safety rules/regulations are not followed, injury to personnel and/or damage to test items could occur.

Emergency telephone numbers are as follows:

Safety	
Ambulance	4-0046
Fire	112
Security	117
Utilities	4-4357
Medical Cont	4-3919
Communication D	4-2390
Communication Rep	air 4-1771

Prior to starting work in 4619 a visual inspection of work area 3.2 shall be made for anomalies by task supervisor and safety

MSFC TE __ MSFC SE Date / Time: 09/25/93

Personnel shall not work or position themselves beneath 3.3 suspended loads unless such loads are securely and adequately blocked up.

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- Objects handled by overhead hoist shall be lifted only high 3.4 enough to clear fixed objects in the path of travel. Spreader bars and slings may be left on the hoist if desired when not in use, but must be raised so that the lowest part of the lifting equipment will be at least seven feet from the floor when not in
- Crane, hoist, lift prime operators, and riggers shall be certified 3.5 according to the latest revision of MMI 1710.6, and shall have in their possession a valid certification card.

Certifications	checked	by:
----------------	---------	-----

Date / Time:

04/25/43 11.15 c.n.

- Personnel working around suspended loads shall be alert to 3.6 the possibility of being crushed between the suspended load 3.7
- Loads shall be moved slowly so they will not accumulate more momentum than can be stopped with little or no swing.
- Where handling slings are called out, a sling with more 3.8 pickup points than required may be used if the weight capacity per point used is equal or greater than the weight capacity of each point of the noted sling and the free pickup point is (are) secured to prevent it (them) from swinging and causing damage to parts.
- 3.9 Only the area coordinator should direct the crane moves, however, any person determining an immediate danger or problem may request stoppage of activities. 3.10
- The lifting or transportation operation shall be halted by the area coordinator at any time the control area cannot be maintained.
- Steel toe shoes are required during lifting operations. 3.11 Hardhats are required when the lift is at or above the shoulders.
- Tag line operators are to wear leather gloves. 3.12 3.13
- The primary safety hazards associated with this operation are:
 - 3.13.1 Lift operations
 - 3.13.2 Solvent Use (See NOTE)
 - 3.13.3 Live (Loaded) Solid Rocket Motor

NOTE: Grease and solvent use are only "if needed" as determined by the MSFC TE and CSD TE.

- 3.14 Any time a crane is being used, it must be dogged if:
- 3.14.1 The load will be suspended in a static condition for an extended amount of time.
- 3.14.2 A crane operator crew change or substitution must be made.
- 3.15 No electric power tools shall be used near the live test item. Use of pneumatic tools is acceptable.
- 3.16 All ground cables and ground straps end-to-end resistances shall be verified with a multimeter. These resistances must measure less than 1 ohm.
- 3.17 All personnel within touching distance shall wear a wrist strap that has been checked with a wrist strap checker. This step should be performed each time the wrist strap ground is broken.
- 3.18 All personnel within touching distance of open grain propellant (and ordnance) shall wear antistatic coveralls.

4.0 Test Items and Test Requirements

4.1 Test Items

The test item for the vibration tests consist of a BSM which will be tested in the aft motor configuration. The motor will be tested with an aero heat shield over the exit cone. The motor weighs approximately 154 pounds.

Motor Serial Number 1000734 Conditioning Temp. 25°F +0 °F

4.2 Test Requirements

4.2.1 Test Tolerances

The tolerances applicable to the test conditions are as follows: (Unless otherwise stated in the procedure)

Vibration Frequency: ± 5%
Test Duration: +10%, -0%
Temperature: ± 5° F
Sinusoidal Control Signal ±10%
Maximum Harmonic Distortion
Sinusoidal Peak Acceleration +20%, -10%

Composite Root Mean Square Acceleration

±10%

Acceleration Spectral Density

+100%, -25% (+3dB, -1.5dB)

4.2.2 Test Data

All data taken with non-recording instruments will be recorded in ink directly onto data sheets and/or log sheets. The log or data sheets will identify the test being performed, the test item, the item part number, and the applicable test procedure. Corrections or changes will be made by drawing a single line through the original entry. The new entry will be made directly above the old and initialed by the person making the entry. Each page will be signed and dated at the bottom of the page by the person making the entries, and counter signed Test Conditions

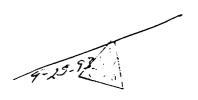
4.3

The live delta qualification motor will be vibration tested at a specific temperature. The motor will either be tested at 25°F (+0, -5 °F) or at 125°F (+5, -0 °F) depending on which qualification motor this procedure controls.

The MSFC TE shall check with the Army MET team to ensure that (MET team phone number....876-2465).



- 4.3.1.1 If lightning is within 10 miles during any time that a live BSM is in building 4619, the MSFC TE shall make arrangements to disconnect the motor ground from the facility ground. The motor shall remain ungrounded until the lightning is out of range.
- When reconnecting the ground after a lightning storm, a 100Kohm resistor should be connected to the ground wire from the motor before connecting to facility ground. This allows any charge on the motor to slowly dissipate to ground. The resistor should be left connected for no less than 30 seconds.
- After the specified time, disconnect the ground wire from facility ground and remove the resistor. Reconnect the ground strap from the motor to facility ground.



The test site's relative humidity must be above 20%. If the humidity 4.3.2 is below 20%, all test operations must cease until favorable weather

Test site's relative humidity 71% MSFC TE MB

4.4

4.4.1 All measurements shall be made with instruments and equipment whose accuracy and/or calibration has been verified.

Calibration Acceptable ______ MSFC TE CSD TE

4.4.2 Proof Loading of Handling Equipment (required for PCH)

- The heaviest lift during all of the delta qualification testing 4.4.2.1 will be lifting the motor while in its shipping container. The motor and shipping container together weigh about 310 lbs. All forklifts and overhead hoists must be load (break) tested to at least 110% of this weight (i.e. 350 lbs.). This test must be performed prior to any handling of the BSM but does not need to be repeated until something other than the BSM is lifted by the same handling equipment. It is therefore recommended that the break tests be performed each evening before the BSM testing commences. The break tests shall be performed as follows:
 - The proof load must be at least 350 lbs. a.
 - Lift the dummy load clear of the ground (less than 1 foot) and b. lower to ground three times, holding for five minutes on the third lift. Lifting straps and spreader bar should be attached

SEE APPENDIX C FOR THE PROOF TEST INSPECTION SHEETS.

- 4.5 **Test Procedure**
- After review and documented approval, a redline change to this procedure may be performed. Approval shall be by a minimum of the MSFC TE, MSFC QA, and MSFC SE.
- As soon as possible after a test failure, a deviation from the specified test environment, or any other incident which affects the test or test item, MSFC will notify the authorized UT/CSD representative of the event verbally and will then generate a Test Procedure Deviation (NASA form 3959). A copy of the Test

Procedure Deviation is presented in Appendix A. Photographs of any discrepancies shall also be taken.

5.0 Personnel Responsibilities

5.1 Test Witnessing

6.0

All tests will be witnessed by the authorized UT/CSD representative and USBI representative. The MSFC test engineer will also witness the testing. Notification of the start of each test shall be communicated to the authorized UT/CSD and USBI representatives and the MSFC safety representative and test engineer at least 2 hours in advance.

	MSFC Safety Notified	_NB		
	UT/CSD Notified	MS		
5.2	The MSFC TE will serve as the ar test. All handling of the BSM wil MSFC TE or cognizant test engine	rea coordinator for the Il be directed by the eer.		
5.3	Jim McGee (vibration) shall be rephotographic coverage of the vibration			
5.4	All involved lab directors and diversion to testing.	vision chiefs shall be notified [v		
5.5	The area around the outside of the secured before the live BSM is bro	ne vibration facility shall be [9]		
	Area secured? YES NO	MSFC TE MSFC SE		
	Comments: Doors locked, securit			
Vibr	Vibration Tests			
6.0.1	Make sure the CSD TE has reviewed the vibration tests.	e calibrations for the		
6.0.2	Open the doors that enter the vibration thigh bay of bldg. 4619.	test room from the		
6.1	Re-check system setup. Verify char	mber temperature.		

4-25-83/2

- 6.2 Radial Axis Tests
- 6.2.1 Assemble the leg supports on the conditioning chamber.

M

- 6.2.2 Lift Off Vibration
- 6.2.2.1 The following levels and conditions apply for the lift off vibration tests. Vibrate the motor only as follows for a duration of 60 seconds:

[17

Frequency (Hz)	Level
20 20 to 55 55 to 200 200 to 280 280 to 1200 1200 to 2000 2000	$0.017 \mathrm{g}^2/\mathrm{Hz}$ +6 db/octave $0.077 \mathrm{g}^2/\mathrm{Hz}$ -11 db/octave $0.022 \mathrm{g}^2/\mathrm{Hz}$ -4.5 db/octave $0.010 \mathrm{g}^2/\mathrm{Hz}$

Composite: 6.9 grms

- 6.2.3 Boost Vibration
- 6.2.3.1 The following levels and conditions apply for the boost vibration tests. Vibrate the motor only as follows for a duration of 120 seconds:

V

Frequency (Hz)	Level	
20 to 200	$0.54~\mathrm{g^2/Hz}$	
200 to 350	-12 db/octave	
350 to 1000		
1000 to 2000	$0.060 \text{ g}^2/\text{Hz}$ -6 db/octave	
2000		
	$0.015 \text{g}^2/\text{Hz}$	

Composite: 14.0 grms

- 6.2.4 Vehicle Dynamics Vibration
- 6.2.4.1 The following levels and conditions apply for the vehicle dynamics tests. Vibrate the motor only as follows:

Frequency (Hz)	Level
5 to 10	0.7 g peak
10 to 40	3.7 g peak

Sweep Rate: 3 octaves per minute

9.25.93

6.3	Transport Motor From Room 150	
6.3.1	Transport Motor From Room 156 to Room 158/ Setup for T Remove leg supports from conditioning chamber.	ang. Axis
6.3.2	Disconnect the conditioning unit c	[4
6.3.3	Disconnect the conditioning unit from the conditioning chamber. Inspection certifications shall be provided for the overhead Cranes in 4619.	M
C	Crane #1, Bldg. 4619 rm. 156 certification provided	see dev. 2
C	Crane #2, Bldg. 4619 rm. 158 certification provided	
6.3.4 C	Certifications for all lifting fixtures shall be provided:	
Li	assembly certification	
Li	rings (D-rings)	
	UTION: Be careful not to disconnect the motor ground while lifting.	
6.3.5 Usin vibra Reco 6.3.6 Verif groun 6.3.7 Disco	ITION: The following step involves working with a susper load. Keep feet and hands out from under the lost on the overhead crane, lift the conditioning chamber off of the ration table and place it on the floor. Ord time when chamber was removed 12.06 pm 09/25/93 fy motor ground connection on the motor and at the facility	nded ad.
instru with r	onnect the instrumentation wires. Remove any other umentation that is no longer needed or that might interfere motor transport.	M
O.O.O ALTACE	motor transport. Pigg-25-95 h the lifting straps (as shown in Fig. 1a) to the motor preader bar and hook to the overhead crane.	
6.3.9 Remov	ye adapter plate to vibration table fasteners.	[4]
	while lifting.	M
CAUTIO	ON: The following step involves working with a suspende load. Keep feet and hands out from under the load.	d

4.25.93

Grands were interested.

,	6.	3.10 Slowl roll ca	y lift the motor off of the table and place it on the facility's	5.Y
	6.3		ok spreader bar from lifting straps. Leave straps wrapped the motor.	(v)
	6.3		the doors that enter the high bay in room 158.	()
		CAUTION	the high pay in room 158.	سهون
		CACTION	: Make sure that the ground strap is long enough to reach to room 158 during the transport from one reto the other.	oom .
	6.3.		pull the motor using the roll cart from room 156 to room 158.	M
	6.3.	Attach	spreader bar to lifting straps and the overhead crane.	/
		0.10110IN;	Be careful not to disconnect the motor ground while lifting.	G.
		CAUTION:	The following step involves working with a suspend load. Keep feet and hands out from under the load	leđ
	6.3.1			•
	004		e overhead crane, lift the motor from the pull cart e it on the vibration table.	14
	6.3.16	- 41811 (116	adapter plates with the holes on the table.	
	6.3.17	rasten th fasteners.	e adapter plates to the table using the facility supplied Torque these fasteners to 65 ft-lbs	14 [4]
		Record tor	que value: 65 ft-165 MSFC QA RC	
	2011	Torque wr	ench SN: BTW - ZRCE	
	6.3.18	Remove al	l lifting hardware.	
	6.3.19		elerometers to the motor (a	M
	6.3.20	Reconnect	accelerometer wires.	N
•	6.4		nditioning Setup for Tangential and Longitudinal	N N
_	241	T	laurongitudinal	
•	5.4.1 i	Use the overh the motor.	ead crane to place the conditioning chamber over	4
6	.4.2	Once the chan	•	*1 */

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Make sure the chamber thermocouple is in the correct position 6.4.3 for measuring the air temperature around the motor. 6.4.4 Make sure the motor ground strap is secured. Activate conditioning unit and monitor the temperature until it 6.4.5 has stabilized to the desired temperature. Record time/temp. when stabilized: 12:28 225 F temp lowered to 21.9 F Record total time out of conditioning: 22.5 min network testing Recondition motor for twice the time out of conditioning if out more 6.4.6 than 30 minutes. Reconditioning necessary: Yes (No) If yes, how long does motor need reconditioned? 6.5 **Tangential Axis Tests** 6.5.1 Lift Off Vibration 6.5.1.1 The following levels and conditions apply for the lift off vibration tests. Vibrate the motor only as follows for a duration of 60 seconds: Frequency (Hz) Level

 $0.016 \, \mathrm{g}^2/\mathrm{Hz}$

 $0.060 \, \text{g}^2/\text{Hz}$

-3 db/octave

 $0.030 \, g^2/Hz$

+3 db/octave

Composite: 10.0 grms

6.5.2 Boost Vibration

20 20 to 75

75 to 1000

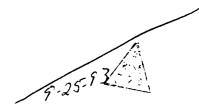
1000 to 2000

2000

6.5.2.1 The following levels and conditions apply for the boost vibration tests. Vibrate the motor only as follows for a duration of 120 seconds.

Frequency (Hz)	Level
20 to 800 800 to 2000	0.24 g ² /Hz -4 db/octave
2000	$0.071 \text{g}^2/\text{Hz}$

Composite: 18.4 grms



M

6.5	.3 Vehicle I	Dynamics		
6.5	.3.1 The foll tests. V	owing levels and dibrate the motor of	conditions apply for the vehicle dynamics only as follows:	M
	Freq	uency (Hz)	Level	
		to 10 0 to 40	0.7 g peak 4.3 g peak	
		Sweep Rate: 3 o	ctaves per minute	
6.6	Axis Cha	ange From Tang	gential to Longitudinal	
6.6.1	Disconnec	et conditioning un	it from conditioning chamber.	14
6.6.2	Attach ove	erhead crane to th	ne conditioning chamber.	[Y]
6.6.3	and and	the conditioning t move it away fron Disconnect lifting	oox off of the test item and move it n the vibration table and place on g hardware.	[4
	Record tim	e of chamber rem	noval: 1:29 pm. 01/25/93	
6.6.4		or ground connect	tion on the motor and at the facility	M
6.6.5	Remove ad	apter plate to vibr	ration table fasteners.	li/
6.6.6	Unhook con	ntrol acceleromet	er.	
1	CAUTION:	Be careful not changing the	t to disconnect the ground when axis on the table.	
(CAUTION:		step involves working with a suspend et and hands out from under the load	ded L
6.6.7	Rotate the p Disconnect		assembly 90° using the areahand	N
6.6.8	Re-attach ac Torque to 65	dapter plate to vib ft-lbs.	oration table fasteners.	[4]
	Record torqu	ie value: 65 ft-1	MSFC QA RC	
		ch SN: BTW- LR		
6.6.9	Reconnect c	ontrol accelerome	eter.	[i]

9-25-93/11

6.6.10	Reconnect lifting hardware to the conditioning chamber and place it over the motor. Reconnect chamber legs as necessary.	N
6.6.11	If necessary, re-attach hoses, instrumentation, etc., before starting conditioning unit.	N
6.6.12	Start conditioning unit. Monitor until it has stabilized to the desired temperature.	[4]
	Record time/temp. when stabilized: 1:55 p.m. C25 F Stabilized at 23 Record total time out of tolerance: 26 min	<u>25</u> °=
6.6.13	Recondition motor for twice the time out of tolerance if the time out was greater than 30 minutes.	M
	Reconditioning necessary: Yes No If Yes, how long does the motor need reconditioning?	
6.7	Longitudinal Axis Test	

o. 1 Longitudinal Axis Tes

6.7.1 Lift Off Vibration

13---

6.7.1.1 The following levels and conditions apply for the lift off vibration test. Vibrate the motor only as follows for a duration of 60 seconds.

[4]

Frequency (Hz)	Level	
20	$0.016 \mathrm{g}^2/\mathrm{Hz}$	
20 to 75	+3 db/octave	
75 to 1000	$0.060 \mathrm{g^2/Hz}$	
1000 to 2000	-3 db/octave	
2000	$0.030 \text{g}^2/\text{Hz}$	

Composite: 10.0 grms

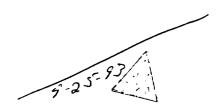
6.7.2 Boost Vibration

6.7.2.1 The following levels and conditions apply for the boost vibration test. Vibrate the motor only as follows for a duration of 120 seconds.

W/

requency (Hz)	<u>Level</u>	
20 to 800	$0.24~\mathrm{g^2/Hz}$	
800 to 2000	-4 db/octave	
2000	$0.071 \mathrm{g}^2/\mathrm{Hz}$	

Composite: 18.4 grms



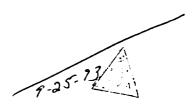
6.7.3	3 Vehicle Dynamics		
6.7.3	3.1 The following levels a test. Vibrate the motor	nd conditions apply for the vehicle dynamics or only as follows.	N
	Frequency (Hz)	<u>Level</u>	
	5 to 10 10 to 40	0.7 g peak 4.3 g peak	
	Sweep Rate:	3 octaves per minute	
6.8	Post Test Inspection		
6.8.1		be visually inspected by the MSFC QA, TE for exterior damage resulting from 3 fasteners deterqued slightly	[4]
6.8.2	Remove all instruments	, and the second	M
6.9	Data Requirements		
	test tolerances shall be of plots. Acceleration vers	(PSD) plots for all control and response f and boost tests shall be recorded. The overplotted on the control accelerometers us frequency plots shall be recorded for all ring vehicle dynamics tests.	
Post	Test Disassembly/Prer	pare for Shipment	
7.1	Conditioning Chamb	er Removal	
7.1.1	Disconnect any hoses and the removal of the cham	nd instrumentation that hinders ber.	[V]
7.1.2	Using the overhead cran off of the vibration table	e, slowly lift the conditioning chamber and place on the floor.	[1]
7.1.3	Move chamber out of the	way.	M
7.1.4	Move the conditioning ur	nit out of the way if necessary.	[4]
7.1.5	Verify motor ground conground contact point.	nection on the motor and at the facility	M
7.1.6	Remove vibration table in	nsulation.	19

7.0

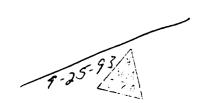


	WARNING: Removing the Aero Heat Shield exposes the motor' propellant grain. Personnel should use caution du any operations with and exposed grain. Tools, watches, eye glasses, etc., should be tethered (if necessary) to prevent dropping anything into the motor.	s ıring
7.2.1	1 Make sure the motor ground is secured.	r. 2
7.2.2	Make sure verified wrist straps are being worn by the personnel removing the aero heat shield.	[17]
7.2.3	Remove the fasteners from the Aero Heat Shield. Place the fasteners in a marked bag.	[y]
7.2.3	SLOWLY remove the Aero Heat Shield.	[4
7.2.5	Remove the heat shield seal. Do not drop the seal into the motor.	[i]
7.3	Post Test Inspection of Motor Propellant Grain	[•]
7.3.1		M
7.3.2	Clear area of all non-essential personnel. Only the grain inspectors (2) and the MSFC TE shall remain.	[1]
7.3.3	Verify grain inspector(s) is(are):	r. 2
	a. Wearing 100% cotton coveralls, shorts, and undershirts.	ιγji
	b. Wearing a wrist strap.	
	c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.	
7.3.4	Perform grain inspection.	
	Cracked propellant yes	[4]
	If yes, give approximate location and size of crack:	

7.2 Aero Heat Shield Removal

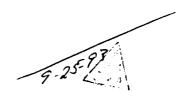


Other comments on grain condition: MSFC QA A draw-wire, fabric, security bag shall be installed over the nozzle exit cone. The bag shall be closed around the exit cone and secured by inserting the bag wire ends through a standard [X]security lead-seal (i.e. cover the exit cone the same way that it 7.4 Adapter Plate Removal 7.4.1 Remove the adapter plate to vibration table fasteners. 7.4.2 Attach lifting straps as shown in Fig. 1b (Appendix B). M CAUTION: Be careful not to disconnect the ground while $[\mathcal{X}]$ lifting the motor. CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load. 7.4.3 Lift the motor off of the vibration table and move to an area near the wood supports. 7.4.4 Lower the motor so that it rests on the wood supports. 7.4.5 Rotate the motor 180° so that the adapter plates face up. 7.4.6 Remove the bracket to adapter plate fasteners. Place fasteners CAUTION: Be careful not to disconnect the ground while lifting the motor. CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load. 7.5 Aft Skirt Bracket Removal 7.5.1 Remove the aft end motor to bracket fasteners (12 places).



Place fasteners in a marked bag.

<u> </u>	CAUTION:	Be careful not to disconnect the ground while lifting the motor.	e
	CAUTION:	The following step involves working with a sulload. Keep hands and feet out for	
7	1.5.2 Lift the mot	or to waist height using the overhead crane.	e load.
7	.5.3 Rotate the m fastener hold	notor 180° so that the bracket to adapter plate	[Y]
7.		otor so that it rests on the wood supports.	[4]
	Place fastene	ard end motor to bracket fasteners (8 places).	[Y
8.0 Re	turn Motor to	the Vertical Position two face.	
8.1	Attach 2 D-ris to the aft end	ngs, 180 degrees apart, and one lifting strap holes of the motor.	[1]
8.2		eak-over" brackets (and lifting strap) to the lit holes on the forward face of the motor case.	[4]
8.3	Attach the aft	lifting strap to the overhead crane hook.	
	lo	he following steps involve working with a susp ad. Keep hands and feet out from	
	lif	ting the motor.	oad.
8.4	One person (as strap on the for lifted from the a it to a vertical person of the strain of the strai	chosen by the MSFC TE) shall hold the lifting ward end to keep the motor from swinging when ft end. Slowly lift the aft end of the motor to bring osition.	[1]
8.5		so that the aft end is at waist height.	
80	LAUTION: The load	e following steps involve working with a suspend. Keep hands and feet out from	nded
8.6	Disconnect the "I marked bag.	oreak-over" brackets. Place brackets in a	(A)



Place Motor In Shipping Container _ 9.0 Remove lid from shipping container by removing the lock-ring 9.1 bolt and nut, lockring, and cover. (See Fig. 3 for an overall view of the shipping container). Remove top cushion insert. Make sure that the top bearing plate 9.2 is properly oriented to the relative location of the drum humidity indicator/pressure relief valve (see Fig. 4). If not as shown (the two 1-inch dia. clearance holes must straddle the (imaginary) horizontal center line) the center cushion insert, as a unit (do not lift center insert...it's keyed to the bottom insert) must be rotated to bring the top plate into proper position as shown. Remove the bearing plate from the tie rods. DO NOT remove the 9.3 Remove and discard any old bags of desiccant. 9.4 Drape the loose end of the container ground strap over the edge 9.5 of the container. Visually inspect the container interior to assure it is free of any 9.6 foreign matter. Vacuum interior if required. Attach a ground wire to facility ground and verify its resistance. 9.7 Resistance shall measure less than one (1) ohm. Resistance measured: ______MSFC QA ______ Connect this ground wire to the motor shipping container and 9.8 verify the resistance (<1 ohm) 14 Resistance measured: ______ MSFC QA____ Install the antistatic foamed plastic liner tightly around the motor 9.9 case, and secure in place by taping the liner's vertical butt joint (trim as required) using 2" wide tape. No tape used. NB ogkilgs Install the antistatic plastic film bag, up and over the motor. 9.10 Visually orientate the motor nozzle cant to the side of the container 9.11 indicated by the marking, "POSITION NOZZLE CANT THIS SIDE" CAUTION: Be careful not to disconnect the motor ground while lowering the motor into the container.

9.25-93

CAUTION: The following steps involve working with a suspended load. Keep hands and feet out from under the load. CAUTION: When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may continue. If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect larger resistor (100 Kohm min.) to allow a slow discharge of the motor case. If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety, and evacuate all personnel to safe locations. Slowly lower the motor into the container while monitoring 9.12 Record Stat Gun SN: ______ No reading CAUTION: Make new ground before breaking old ground. Attach the container ground wire to the motor using the 1/4-20 UNC x 3/4 long bolt and nut provided. Torque to 50 in-lbs ± 5 in-lbs. Measure resistance to verify ground (should be <1 ohm). [d Record torque value: 50 (2-165 MSFC QA PC Disconnect ground wire connecting the motor and facility ground. Remove lifting hardware.

9.13

9.14

9.15

9.10	by the mark NOZZLE C bring it to r to 20 in-lbs		W
	Record torqu	ue value: _ 70 in-lis _ MSFC QA _ DE	
	Torque wren	nch SN:	
	CAUTION:	Make sure that the top bearing plate is indexed to the motor case O.D. and is resting flat on the top of the flange.	he
		Also, make sure that the grounding strap terminal and attach nut and bolt head is positioned in the clearance hole in the plate.	
9.17	Place twelve container in	e (12) 16 unit size bags of fresh desiccant into the the cavity around the top bearing plate.	(J
	CAUTION:	Once the bagged desiccant has been put into the container, the remaining packaging steps must be completed immediately and the container closed to prevent the desiccant from over exposure to free air circulation.	d
		If, after the desiccant has been placed into the container, the packaging cannot be completed, close the container until packaging can be resumed	•
9.18	Install the to the bottom fa plate.	p cushion insert. Make sure that its index slot, on ice, matches with the index block on the top bearing	N
9.19	mo a suriant		[J
9.20	Place the con is no foreign	tainer lid onto the container, making sure that there matter on the lid gasket or container rim.	[4]
9.21	nerweett mie (ckring, with its bolt flanges positioned (centered) container humidity indicator and lifting grip. t and nut and torque to 6 ft-lbs ± 1/2 ft-lbs (72 in-lbs).	[]
	Record torque	value: 6 ft-155 MSFC QA RC	

Torque wrench SN: 68/80

NOTE: The lockring shall be tapped, using a rubber mallet, at various points around the ring during bolt tightening.

9.22 Install a standard wire and lead seal through the provided holes in the lockring bolt flanges. Secure using a QC press die engraved - MS 09/25/43 Payl 9-25-42

NOTE: Before shipping, USBI personnel shall make sure the shipping container is properly labeled. Reference CSD's Material Handling Card, Rev. C, dated 5-23-89 sections

10.0 Test Report

A final test report will be submitted to UT/CSD within 30 working days after testing is completed. Three copies plus one reproducible copy of this report will be submitted containing the following information as a minimum:

- A. A description of test mounting and setup and location of instrumentation with two sets of color still photographs
- (8-1/2 by 11 inches) of setups and instrumentation close-ups. B. A list of all instrumentation and equipment with ranges and plot accuracy of all acquired data with objective evidence of C. Sketches of test setups.
- D. Power spectral density (PSD) plots of all acceleration data.
- E. The results of all inspections and tests performed i.e., data tapes, data plots, and completed data summary sheets.
- F. Any alteration or deviation from this procedure will be described in detail by a Notice of Deviation and included in
- G. Model numbers and serial numbers for all instrumentation and test equipment shall be included in the report.

__11.0 Post Test Verification

The procedure delineated in the above document has been satisfactorily completed and :

- a. All sequences in the procedure have been completed (or deleted by approved deviation)
- b. All Procedure changes have been recorded and approved.

Submitted Verified by:	Vat Benell
	Test Engineer

Date: _09/25/93

Motor Serial Number: 1000734

Appendix A

Test Procedure Deviation

TEST ENGINEER:	TEST PROCEDURE DEVIATION	TCP NO.
Mat Bevill V	ONSTAND OUALITY	BSM-TCP-FOFA
REQUIREMENTS ENGINEER:	RICK (lements RC 9-	DATE OATE
TITLE:	0.1.1	09/25/93
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1 1 16	od fall	100073
	anher tems	and Alic c
2	tor the aft motor (man AH) tasteners p
	ander temp. Olia	200174).
'	testing. Mex temp during tes. Tolerance States 25°F + 0°F	tolerano 1
	Toleran temp during to	has toring
	States 25°F +0°F	11 Mai 28.2°F
	1 """(Ed (1/1)	
	for chamber temp was the	ed before process
	Motor chamber temp was stabilized before testing on Radial Aris Tu	at 222.50F
	1 May la	ole.
	•	
TOA:		
Mot Beville		
EVIATIONISI INCREASE HAZAGO	62 ORGANIZ	
NO	EVEL SAFETY OF O NASA	MIFC EPIZ VIATIONISI AFFECT TEST REQUIRE
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- . • 1	TION(5)	INCREASE HAZARE	LEVEL: SAFETY-	ABOVE DEVIATIONIS ASSE		
			63	ABOVE DEVIATIONIS) AFFEC	T TEST REQUIRE.	

TEST PROCEDURE DEVIATION									
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figure 2 DEVIATION LOG

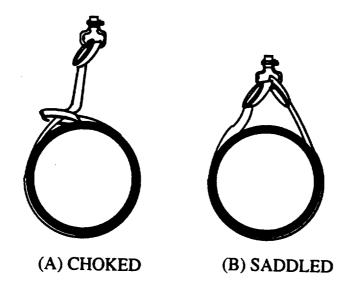
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**BL P Colum of lest lupper leap violation, radial axis Tokotos osterlas 65

Appendix B

Figures



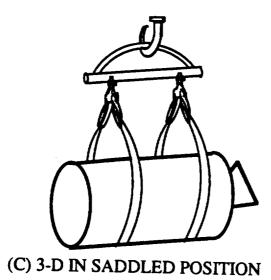


FIGURE 1. LIFTING STRAP ATTACHMENTS

DRAWN BY: IL MITCHELLÆPS4 3/8/93

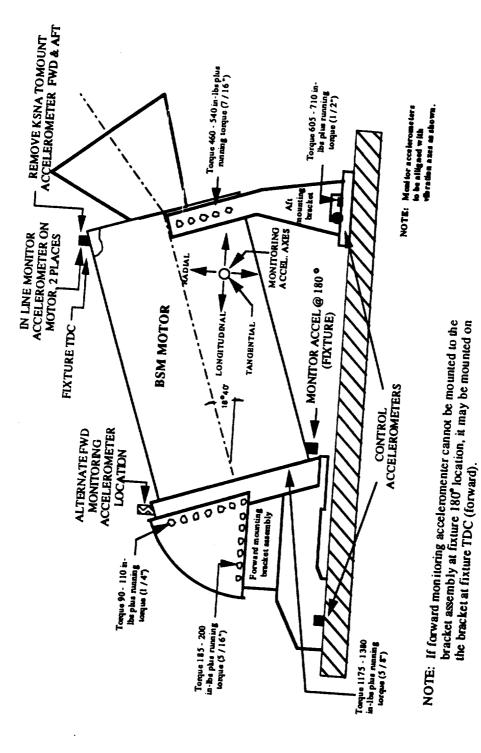


FIGURE 2. VIBRATION TEST SETUP

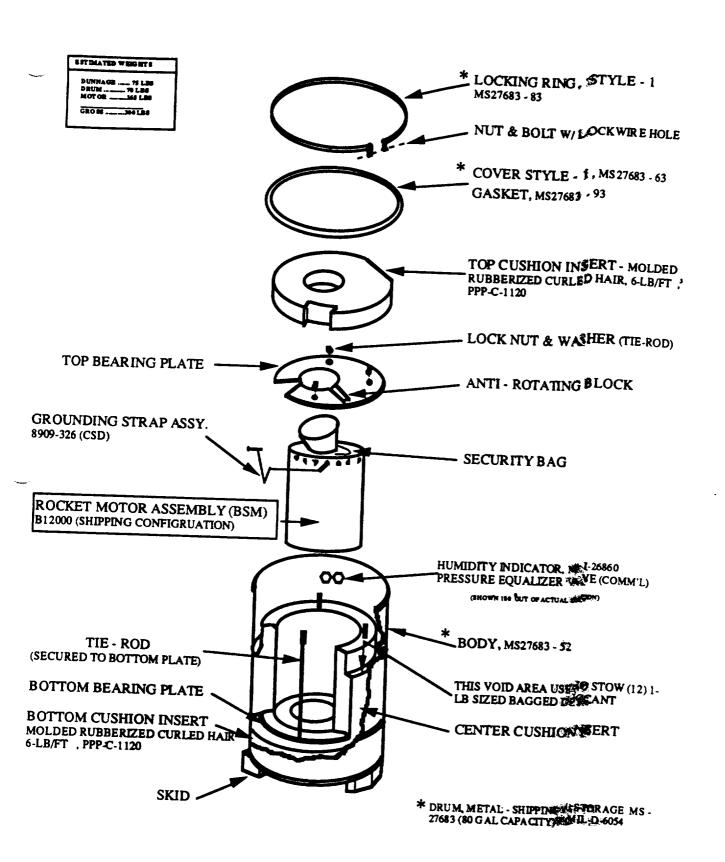
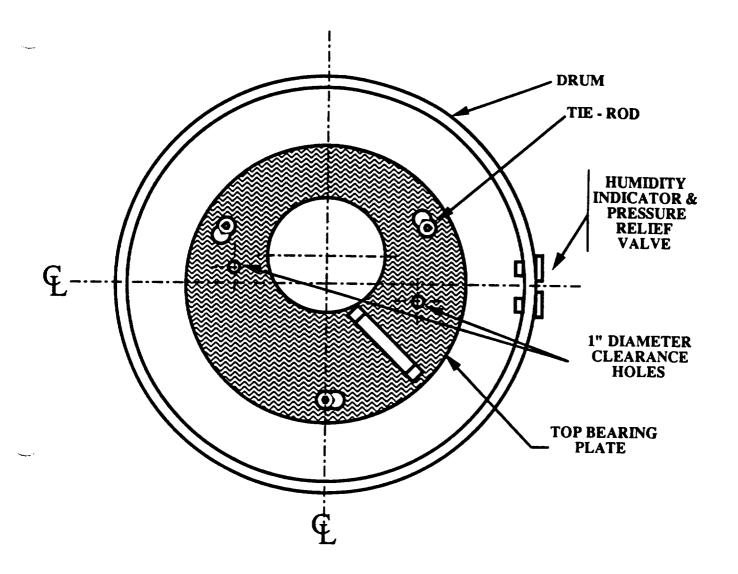


FIGURE 3. OVERALL VIEW OF SHIPPING CONTINER



VIEW LOOKING DOWN AT OPEN DRUM

FIGURE 4. Top View of Shipping Container

DRAWN BY: K.MITCHELL/EPSI 4/7/93

BSM MOTOR S/N 1000738 PYROSHOCK TEST PROCEDURE



George C. Marshall Space Flight Center Marshall Space Flight Center, Alabama 35812

BSM-TCP-EP54-001

BSM Delta Qualification Test

Motor to Bracket Assembly / Pyro Shock Simulation Test Procedure

This Procedure Describes Safety Critical Operations

BSM Delta Qualification Test

Motor to Bracket Assembly / Pyro Shock Simulation Test Procedure

Prepared by:

Mat Bevill EP-12

08/16/93

Motor SN: 1000738

Test Date: 04/20/95 -

Motor to Bracket Assembly/Pyro Shock Simulation

Prepared by:	Mat Bevill MAFC TE/EP12	09/15/93 Date
Approved by:	Jim McGoe/MBFC Vibration Lab TE	9-14-93 Date
	Jun Herring MSFC Fre Shock Lab TE	9-14-93 Date
	Richard Leonard/MSFC Safety/CS01	9-/6-25 Date
	Rick Clements/MSFC Quality/CQ06	7-/5-93 Date
: :	Ben Goldberg/Motor Systems Division/EP11	9/14/43 Date
	Store Branste Oynamie Test Branch/ED73	2/1/23
	Charles E. Wells Chuck Wells/UTC/CSD TE	9/16/9}
	Don Weneil/USBI	9-14-23 Date
	Charlie Lovell/PCH Engineer/CN71	1/10/es

Motor to Bracket Assembly/Pyro Shock Simulation

Prepared by:	Mat Bevill/MSFC TE/EP12	09/15/93 Date
Approved by:	Jim McGee/MSFC Vibration Lab TE	<u>9-14-93</u> Date
	Jun Herring/MSFC Pyro Shock Lab TE	9-14-93 Date
	Richard Leonard/MSFC Safety/CS01	9-16-93 Date
	Rick Clements/MSFC Quality/CQ06	<u>7-/5-93</u> Date
	Ben Goldberg/Motor Systems Division/EP11	<u>9//y/93</u> Date
	Stere Brewster Dynamic Test Branch/ED73	9/14/93 Date
	Chuck Wells/UTC/CSD TE	Date
	Don Wencil/USBI	9-14-23 Date
	Charlie Lovell/PCH Engineer/CN71	<u>0/16/e3</u> Date

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General Information

1.0

-1.0 General Information

1.1 Scope

This test procedure addresses all the requirements to perform pyro shock testing on Booster Separation Motors (BSM). Included in this procedure are the steps to assemble the BSM to the aft skirt support brackets.

1.2 Objective

The objective of the pyro shock testing is to verify the physical and functional survivability of the Booster Separation Motors. Of particular interest for these tests are the components bonded using EA9394 adhesive. The components using this adhesive include the throat insert, the centering insert, and the igniter grain support rod.

2.0 Applicable Documents

MSFC-STD-513A	Certification of Equipment Operations and Materials Handling Personnel
EG5300.36A	Safety
29 CFR 1910	Occupational Safety and Health Administration
NSS/GO 1740.9	Safety Standard for Lifting Devices and Equipment
NHB 1700.1(V1)	Basic Safety Manual
AMC-R 385-100	Safety Manual
EP01-SOP-01	Standard Operating Procedure for Safety Critical
MM 1700.4	Safety and Environmental Health Hazards
MMI 1700.17	MSFC Procedures for Acquiring Shipping Permits for Rocket Motors and Igniters
MMI 1710.1	Safety Review and Approval of Hazardous and Potentially Hazardous Facilities and Activities at MSFC
MMI 1710.6	MSFC Program for Personnel Certification
MMI 1711.2	Mishap Reporting and Investigation

MMI 1845.1 Hazard Communication Program

MMI 6400.2 Packaging, Handling, and Moving Program Critical

MSFC-RQMT-1493 Electrostatic Discharge Control Requirements

MSFC-STD-1800 Electrostatic Discharge (ESD) Control for Propellant and

Explosive Devices

MSFC-STD-126E Inspection, Maintenance, Proof Testing and Certification

of Handling Equipment

CSD-5597-93-1 Rev. B Enhanced Delta Qualification Test Plan for Booster

Separation Motor (BSM), Aug. 6, 1993

10SPC-0067 Rev. A Specification for Booster Separation Motors for Space

Shuttle Solid Rocket Booster (thru SCN 014)

3.0 Safety

The following safety criteria are in accordance with ET01-SOP-3.1 01, Rev. A., "Standard Operation Procedures for Safety Critical Operations". If safety rules/regulations are not followed, injury to personnel and/or damage to test items could occur.

Emergency telephone numbers are as follows:

Safety 4-0046 Ambulance 112 Fire 117 Security 4-4357 Utilities 4-3919 Medical Center 4-2390 Communication Repair 4-1771

- In the event of serious personnel injury, do not move the injured person unless necessary to prevent further serious injury. Call 112 for ambulance.
- 3.2 Prior to starting work in 4619 a visual inspection of the work area shall be made for anomalies by the MSFC TE and MSFC SE.

_ MSFC SE

Date / Time: 69/20/93

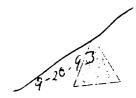
- 3.3 Personnel shall not work or position themselves beneath suspended loads unless such loads are securely and adequately blocked up.
- 3.4 Objects handled by overhead hoist shall be lifted only high enough to clear fixed objects in the path of travel. Spreader bars and slings may be left on the hoist if desired when not in use, but must be raised so that the lowest part of the lifting equipment will be at least seven feet from the floor when not in use.
- 3.5 Crane, hoist, prime lift operators, and riggers shall be certified according to the latest revision of MMI 1710.6, and shall have in their possession a valid certification card.

Certifications checked by:

Date / Time:

09/20/93 6.00 pm.

- 3.6 Personnel working around suspended loads shall be alert to the possibility of being crushed between the suspended load and a fixed object.
- 3.7 Loads shall be moved slowly so they will not accumulate more momentum than can be stopped with little or no swing.
- Where handling slings are called out, a sling with more pickup points than required may be used if the weight capacity per point used is equal or greater than the weight capacity of each point of the noted sling and the free pickup point is (are) secured to prevent it (them) from swinging and causing damage to parts.
- 3.9 Only the area coordinator should direct the crane moves, however, any person determining an immediate danger or problem may request stoppage of activities.
- 3.10 The lifting or transportation operation shall be halted by the area coordinator at any time the control area cannot be maintained.
- 3.11 Steel toe shoes are required during lifting operations. Hardhats are required when the lift is at or above the shoulders.
- 3.12 Tag line operators are to wear leather gloves.



- The primary safety hazards associated with this operation are: 3.13
 - 3.13.1 Lift operations
 - 3.13.2 Solvent Use (See NOTE)
 - 3.13.3 Live (Loaded) Solid Rocket Motor (propellant

NOTE: Grease and solvent use are only "if needed" as determined by the MSFC TE and CSD TE.

- 3.14 Any time a crane is being used, it must be dogged if:
 - The load will be suspended in a static condition for an
- A crane operator crew change or substitution must be
- No electric power tools shall be used near the live test item. 3.15 Use of pneumatic tools is acceptable.
- All ground cables and ground straps end-to-end resistances 3.16 shall be verified with a multimeter. These resistances must measure less than 1 ohm.
- All personnel within touching distance of the BSM or ordnance 3.17 shall wear a wrist strap that has been checked with a wrist 3.18
- All personnel within touching distance of open grain propellant (and ordnance) shall wear antistatic coveralls.
- Wrist strap connections to facility ground must be verified. This step 3.19 should be performed each time the wrist strap ground is broken. 3.20
- In case of an accidental BSM ignition, the nearest fire alarm pull station shall be activated in order to evacuate building 4619. Personnel shall stay clear of the test site until the emergency response personnel have given the "all clear" to return to the

Test Items and Test Requirements 4.0

4.1 Test Items

The test item for the qualification pyro shock tests consists of a live BSM which will be tested in the aft motor configuration. The motor will be tested with an aero heat shield over the exit cone. The motor weighs approximately 154 pounds.

4.2 Test Requirements

4.2.1 Test Tolerances

Unless otherwise stated in this procedure, the tolerances applicable to the test conditions described shall be as specified in MIL-STD-810D. These tolerances are as follows:

Shock Response Spectrum:

+6dB, -3dB (when analyzed with a 1/3 octave shock spectrum analyzer and 5% damping)

4.2.2 Test Data

All data taken with non-recording instruments will be recorded in ink directly onto data sheets and/or log sheets. The log or data sheets will identify the test being performed, the test item, the item part number, and the applicable test procedure. Corrections or changes will be made by drawing a single line through the original entry. The new entry will be made directly above the old and initialed by the person making the entry. Each page will be signed and dated at the bottom of the page by the person making the entries, and counter signed by the test engineer after review.

4.3 Test Conditions

- 4.3.0 The pyrotechnic shock tests for both motors will be conducted at the test site's ambient temperature.
- 4.3.1 The MSFC TE shall check with the Army MET team to ensure that there is no lightning within 10 miles.

 (MET team phone number....876-2465).
- 4.3.1.1 If lightning is within 10 miles during any time that a live BSM is in building 4619, the MSFC TE shall make arrangements to disconnect the motor ground from the facility ground. The motor shall remain ungrounded until the lightning is out of range.
- 4.3.1.2 When reconnecting the ground after a lightning storm, a 100Kohm resistor should be connected to the ground wire from the motor before connecting to facility ground. This allows any charge on the motor to slowly dissipate to ground. The resistor should be left connected for no less than 30 seconds.
- 4.3.1.3 After the specified time, disconnect the ground wire from facility ground and remove the resistor. Reconnect the ground strap from the motor to facility ground.

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The test site's relative humidity must be above 20%. If the humidity 4.3.2 is below 20%, all test operations must cease until favorable weather

Test site's relative humidity 97% MSFC TE

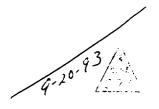
- 4.4 Test Equipment
- All measurements shall be made with instruments and equipment whose accuracy and/or calibration has been

Calibration Acceptable_ (MFSC TE)

- 4.4.2 Proof Loading of Handling Equipment (required for PCH)
- 4.4.2.1 The heaviest lift during all of the delta qualification testing will be lifting the motor while in its shipping container. The motor and shipping container together weigh about 310 lbs. All forklifts and overhead hoists must be load (break) tested to at least 110% of this weight (i.e. 350 lbs.). This test must be performed prior to any handling of the BSM but does not need to be repeated until something other than the BSM is lifted by the same handling equipment. It is therefore recommended that the break tests be performed each evening before the BSM testing commences. The break tests shall be performed as follows: a.
 - The proof load must be at least 350 lbs.
 - Lift the dummy load clear of the ground (less than 1 foot) and lower to ground three times, holding for five minutes on the third lift. Lifting straps and spreader bar should be attached

SEE APPENDIX E FOR THE PROOF TEST INSPECTION SHEETS.

- 4.5 **Test Procedure**
- 4.5.1 After review and documented approval, a redline change to this procedure may be performed. Approval shall be by a minimum of MSFC TE, MSFC SE, and the MSFC QA.
- As soon as possible after a test failure, a deviation from the specified test environment, or any other incident which affects the test or test item, MSFC will notify the authorized UT/CSD representative of the event verbally and will then generate a Test Procedure Deviation (NASA form 3959). A copy of the Test



Procedure Deviation is presented in Appendix B. Photographs of any discrepancies shall also be taken.

5.0 Personnel Responsibilities

5.1 Test Witnessing

All tests will be witnessed by the authorized UT/CSD representative and USBI representative. The MSFC test engineer will also witness the testing. Notification of the start of each test shall be communicated to the authorized UT/CSD and USBI representatives and the MSFC safety representative and test engineer at least 2 hours in advance.

	MSFC Safety Notified	
	UT/CSD Notified	MB_
5.2	The MSFC TE will serve as the test. All handling of the BSM MSFC TE or cognizant test en	will be directed by the
5.3	Jim Herring (pyro shock) shal photographic coverage of the p	l be responsible for pyro shock test activities.
5.4	The area around the outside o secured <i>before</i> the live BSM is	f the pyro shock facility shall be [4] brought to the pyro shock test site.
	Area secured? YES NO	MSFC TE MSFC SE
	Comments:	
5.5	The MSFC TE shall notify the of the BSM. (Fire dept. phone	fire department prior to delivery [/]
5.6	The MSFC TE shall make arrandelivered from the NASA igloo	ngements for the live BSM to be to the pyro shock test site.
5.7	All involved lab directors and prior to testing.	division chiefs shall be notified



6.0 Pyrotechnic Shock Test

6.1 Test Site Preparatory Activities

An inspection shall be made of the hardware to ensure it is all available. Should some hardware be missing the cognizant test engineer shall determine whether those components are required for the safe operation of the procedure. Should they not be required for safe operations, the test engineer shall determine whether an operations halt is required or whether the operations may proceed.

6.1.1 Verify the following components, tools and materials are available and certified (when applicable). All lifting equipment, cables, fixtures, etc... within one year stating the load limit and the date tested stencilled on the equipment.

M

Aft BSM Plate Mounting Hardware:

Part Number	and standware.	
EWB0420-8-23 EWB0420 - 10-(20,-32) TLN1021CPD2-8 TLN1023CD3-10 NAS1587-8C NAS1587-10C	Quantity 6 2 6 2 6 2 2 2	Nomenclature Bolts* Bolts* Nut (SelfAligning) Nut (SelfAligning) Washer Washer

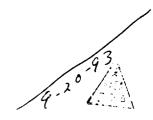
^{* 10107-}XX-XX series bolts are acceptable alternates (-20 for pyro. -32 for vibration)

Aft BSM Bracket Mounting Hardware:

_	TOTAL MOUNTING	g Hardware:
Part Number NAS1955C10H NAS1957C13 NAS1587-5C NAS1587-7C NAS1587-7 VN324BC070	Quantity 8 12 8 12 12 12	Nomenclature Bolts Bolts Washers Washers Washers Locknuts Aero Heat Shield Fasteners
Factor		4
r asten	ers Accounted For:	MR
Breakover brackets		MSFC TE
- contover brackets	2	
Lifting D-rings	_	[1/
		[4

q-20-q3

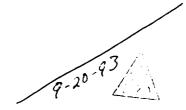
Spreader bar with associated lifting straps and D-rings	N
Custom wood supports to horizontally support the BSM	[A]
Tool Box with Assorted Wrenches Rm 170, Bldg. 4619 (See Appendix D for detailed tool list)	[4]
Pre-drilled Wood Pallet to fit aft skirt support bracket bolt holes	
Lifting straps (3)	[√]
SN: 3298 SN: 3.701 SN: 3208	,
Desiccant (12, 16 unit size bags)	M
Rubber mallet	[V]
Lead wire seal (for security bag)	
Forklift (at least 500 lb. capacity)	M
ESD Scanner	[\]
Materials	_
1,1,1 Trichloroethane; 1 bottle (enough for cleaning)	[0]
MIL-G-4343 grease; 1 container (AHS seal)	M
MIL-T-83483 thread compound; 1 container (AHS)	M
Conoco HD-2 grease; 1 container (bolts, faying surfaces)	M
Other consumables, including rimple cloth, que-tips, tape, bags and towels are also to be supplied if needed.	
Gloves (Latex) Ground straps Wrist stats (5 each) Stat gun (1 each) Ohm meter (1 each) Wrist stat checker (1 each) Chemical safety goggles (2 each) 100 Kohm resistor (1 each)	19 19 19 19 19 19 19 19 19 19 19 19 19 1



	All hardware accounted for: MSFC TE	/
6.1.2	turned off and the emergency brake engaged. Chock at least one of the truck's wheels.	M
	Truck braked and wheel chocked: MSFC TE	,
6.1.3		W
6.1.4	Attach a ground strap (long enough to reach the shipping container on the truck) to the pyro facility ground and verify the resistance. Resistance must be less than 1 ohm.	[1]
	Resistance measured: / MSFC QA	
	CAUTION: Make New Ground Before Braking Old Ground.	
6.1.5	Touch the free end of the ground wire to the truck chassis to make sure the truck and the facility are at the same potential, then, connect the free end of the ground strap to motor shipping container (not to lid or lid bolts).	W
6.1.6	Check continuity of shipping container to ground strap using an ohm meter. Resistance should measure less than 1 ohm.	W
	Resistance Measured / MSFC QA	
6.1.7	Disconnect shipping container-to-truck tie down apparatus. Move tie down out of the way.	[4
6.1.8	Disconnect shipping container to truck chassis ground.	W
	CAUTION: Do Not disconnect the motor's ground wire while removing from the truck.	
6.1.9	Using the fork lift, remove shipping container from truck and set container on the floor in the test room where it may be easily accessed by personnel and the overhead crane. If deemed necessary by the MSFC TE, the overhead crane may be used to remove the shipping container from the truck.	[Y
	Forklift used: yes no Crane used: yes no	
6.1.10	The truck may exit the test area at this time.	
	NOTE: If the truck does not leave the site at this time, the	

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6.1.11	The large pyro bay doors should be "closed in" but left "cracked" open during the assembly and pyro test operations.	M
6.1.12	Install the shock test control equipment on the pyro plate as illustrated in Figure 1 (see Appendix C).	[4]
	Equipment installedMSFC TE	
6.1.13	The pyrotechnic shock test will be conducted in the aft motor configuration.	W
6.2	Pyro Test Setup	
0	Record the test site's temperature and relative humidity. The relative numidity shall be above 20%. If the humidity is not above 20%, all test perations must halt until favorable weather conditions resume.	Ŋ
Т	Cemperature: 74 °F; Relative Humidity 97 %	
	emove Motor From Shipping Container	
6.2.1.0	Verify wrist straps are being used by ALL personnel while working with the live motor. All wrist straps shall be checked with a wrist strap checker before being used. Continuity checks shall be performed on all main ground straps after making any new ground connection.	М
	MSFC SE	
6.2.1.1	Position shipping container so that the overhead crane can easily attach to the test item (this step necessary only if fork lift positioning was not adequate for crane attachment.)	[4]
CAU	UTION: When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.	
	After initial reading over 1.0 kilovolt, repeat electrosta reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations months.	

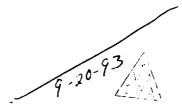


If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety, and evacuate all personnel to safe locations as directed by safety.

WARNING: Do not remove the nozzle's security bag and weather seal. Removing the bag and seal will expose the propellant grain and increase the risk of motor ignition.

6.2.1.2	Open the shipping container and remove all the packing that interferes with the removal of the test item. Monitor static charge while removing packaging.	M
	Record Stat Gun reading~700 Vol+s	
	Record SN of Stat Gun	
	CAUTION: Make New Ground Before Braking Old Ground.	
6.2.1.3	Attach a ground wire to the pyro facility ground and verify its resistance. Resistance shall measure less than 1 ohm. This wire should be attached at a location close to the BSM.	W
	Resistance measured / MSFC QA R	
6.2.1.4	Attach the ground wire in step 6.2.1.3 from the facility ground to the live BSM.	[V
6.2.1.5	Disconnect the motor to shipping container ground wire.	M
6.2.1.6	Disconnect the motor to shipping container ground wire. Attach two lifting rings (along with lifting strap) to the BSM's aft section, 180° apart.	[4]
6.2.1.7	Certifications for all lifting fixtures shall be provided:	[U
	Lifting beam assembly certification provided	
	Lifting rings (D-rings)	



CAUTION: When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.

After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may continue.

If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety, and evacuate all personnel to safe locations as directed by safety.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

6.2.1.8 Slowly, monitoring static charge, lift the motor out of the container using the overhead crane. Lower the test item so that the forward end of the motor is at waist height.

[\]

A detailed visual inspection shall be performed by the MSFC test engineer and the CSD test engineer on the live test items before testing. Record the motor's serial number.

No Damage ____

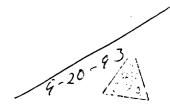
Damage (detail in attachment) Yes, motor to shipping container ground wire Serial Number 1000738 find industry on 314 from find end bio Ken-

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

6.2.1.9 Attach the "break-over" brackets and lifting strap on the forward end of the motor (see Figure 2, Appendix C).

[1]

CAUTION: Do Not disconnect the ground wire while breaking the motor to the horizontal position.



CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

6.2.1.10 Lower the motor on its wood supports so that the motor rests horizontally. The MSFC TE will designate someone to hold the lifting strap on the forward end while placing the motor in the horizontal position (see Figure 3, Appendix C). The person holding the strap should be wearing a wrist strap.

.

6.2.1.11 Unhook the lifting straps and remove lifting hardware.

[4

6.2.1.12 Re-attach the lifting hardware for bracket installation. Attach lifting straps in the saddle position (see Figure 4b, Appendix C).

6.2.2 Attach Motor to the Aft Skirt Support Brackets

Steps 6.2.2.1 and 6.2.2.2 may be skipped if deemed "not necessary" by the MSFC test engineer and the CSD test engineer. However, the fasteners should still be installed with grease applied. If time permits, all of the cleaning and surface preparation may be done *before* the test date.

CAUTION: When using trichloroethane, personnel shall wear chemical goggles and neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

CAUTION: When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

6.2.2.1 Wipe faying surfaces clean with 1,1,1 trichloroethane and apply an unbroken film of HD-2 to each surface.

After assembly remove excess grease with a lint-free cloth.

[4

Surfaces wiped at this time: Yes____No____ Grease applied at this time: Yes___No____

CAUTION: When using trichloroethane, personnel shall wear chemical goggles and neoprene-Latex gloves.

Contaminated materials shall be disposed of as hazardous waste.

CAUTION: When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

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6.2.2.2	Clean washers and bolts with 1,1,1 trichloroethane and install wet with HD-2 grease. After assembly remove excess grease with a lint-free cloth.	1
	Washers cleaned at this time: YesNo	
CAU	UTION: Make sure the motor remains properly grounded during the move to position the test item.	,
6.2.2.3	Position the motor on the wood supports so the forward and aft brackets can be easily attached. Leave lifting straps attached.	1
6.2.2.4	NAS1587-5C washers (8 places) through supports and into threaded inserts of BSM and torque to 145 to 170 in-lbs (13 to 14 ft-lbs) above running torque.	1
	Torque value: 150 in -135 MSFC QA	
	Record SN of torque wrench: $J-247-42$ (4671)	
NO7	TE: The forward attach bracket has an alignment pin so there is only one way it can be installed.	
NOT	TE: Be sure the aft attach bracket is in correct alignment with the forward bracket before installing the aft attach bracket bolts.	
6.2.2.5	At aft end of BSM install NAS1957C13 bolts with NAS1587-7C washers (under bolt head), NAS1587-7 washers (under nut) and VN324BC070 locknuts (12 places) and torque to 460 to 540 in-lbs (39 to 45 ft-lbs) above running torque. * Due to inaccessability bolts were torqued on a best effect "basis."	24 2 4 2 4
	Torque value: 570 14-145 MSFC QA RC WB 9-2	ر د ۱۹ ۶
	Record SN of torque wrench: T-267-62 (4611)	/ 93
6.2.3	Bracket Cover Installation	
6.2.3.1	Bracket cover required? YesNo	
	If yes above, the 1/4 inch diameter bolts shall be torqued to 90-110 inch-pounds above running torque. The 5/16 inch diameter bolts shall be torqued to 185-200 inch-pounds (16 to 17 ft-lbs) above running torque.	
	Torque value: NA MSFC QA NA	
	Record SN of torque wrench:	

9-20-93

	Rotate Motor 90 Degrees for Pyro Plate Mounting	
6.2.4	Rotate Motor 90 Degrees for Pyro Plate Mounting	
6.2.4.0	De-torque and remove the bracket to inspection plate fasteners. Place fasteners in a labeled bag.	[]
6.2.4.1	With the test item resting on the brackets, unhook the belly straps from the horizontal stabilizing bar (lifting straps should still be in the choked position as shown in Figure 4a, Appendix C).	[]
6.2.4.2	Wrap the belly straps around the motor on each end as shown in Figure 4b (saddle configuration, Appendix C).	[]
C	AUTION: Personnel shall not work under or place any body punder a suspended load.	art
C	AUTION: Be careful not to disconnect the motor's ground wind during the lifting and rotation operation.	re
6.2.4.3	Lift the motor and brackets to waist height using the overhead crane so that the motor can be rotated.	[1
6.2.4.4	Holding the motor by the support brackets, rotate the motor 90 degrees so that the brackets can be mounted on the pyro plate.	/
6.2.4.5	Use the overhead crane to move the test item to the mounting area on the pyro plate.	[4]
6.2.5	Attach the Brackets and Shims to the Pyro Plate	
R	EMINDER: Be sure to put the custom shims in their correct positions and orientation before sliding bolts through the pyro plate.	
CA	AUTION: When using grease, personnel shall wear Neoprene- Latex gloves. Contaminated materials shall be disposed of as hazardous waste.	
5.2.5.1	Install wet with grease (HD-2) EWB0420-8-23 bolts (10107-8-23 alternate) with NAS1587-8C washers and TLN1021CPD2-8 self-aligning nuts at "A", "B", and "D" positions (as marked on supports, 6 places) and torque to 605 to 710 in-lbs above running torque. At the "C" position, install EWB0420-10-20 bolts (10107-10-20 alternate) with NAS1587-10C washers and TLN1023CD3-10 self-aligning nuts (2 places) and torque to 1175 to 1380 in-lbs above running torque. Torque value: "C" 105 ff-1bs MSFC QA	

91 C - 2

ORIGINAL PAGE IS OF POOR QUALITY 9-20-93/11

	_	
	Record SN of torque wrench: "L" EMJ00359 A,B,D T- 261-62	(4671)
6.2.5.2	Release the tension from the lifting straps but do not disconnect the straps. These straps may be used to tape off accelerometer wires if necessary.	17
6.2.5.3	Place the pyrotechnic debris shield in front of the large bay doors on the north side of the pyro room.	
6.2.6	Perform Grain Inspection	
6.2.6.1	Clear area of all nonessential personnel for grain inspection. (Only the grain inspectors (2) and the MSFC TE shall remain.)	[Y
6.2.6.2	Verify grain inspector(s) is(are):	
	a. Wearing 100% cotton coveralls, shorts, and undershirts.	N
	b. Wearing a wrist strap.	
	c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.	
6.2.6.3	The grain inspector shall now remove the security bag and cover from the exit cone.	M
6.2.6.4	Perform grain inspection.	
	Cracked propellant? yes	[y]
	If yes, give approximate location and size of crack.	
	Other comments on grain condition;	
	No cracks or other defects	
•	Propellant grain, Small amounts of list	
	OK to perform pyvoshock tost on grain surface,	
(Grain inspector	
	The E stilly 4.3043	
6.2.7 <u>Inst</u>	all Aero Heat Shield	
~ ~ ~ ~ ~	3 8	

CAUTION: When using trichloroethane, personnel shall wear chemical goggles and Neoprene-Latex gloves.

Contaminated materials shall be disposed of as hazardous waste.

9.20.93

6.2.7.1 CLEAN (if necessary) preservative or oil from the ae using a lint-free cloth and 1,1,1 Trichloroethane. DO over the identification.		(if necessary) preservative or oil from the aeroheat shield lint-free cloth and 1,1,1 Trichloroethane. DO NOT clean e identification.	[4
	Cleanin	ng performed: Yes No	
C	AUTION:	When using trichloroethane, personnel shall wear chemical goggles and neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.	
C	AUTION:	When using grease, personnel shall wear Neoprene- Latex gloves. Contaminated materials shall be disposed of as hazardous waste.	
ľ	NOTE:	Dow Corning Moly Kote 55M Silicone O-ring lubricant meets the MIL-G4343 specification.	;
Using a lint-free cloth and 1,1,1 Trichloroethane, an operator wearing a properly grounded wrist stat will CLEAN (if necessary) the sealing surface of the aeroheat shield cover and corresponding nozzle surfaces. LUBRICATE (if necessary) the surfaces with MIL-4343 grease.			
		cleaned: YesNo	
CA	UTION:	When using grease, personnel shall wear neoprene- Latex gloves. Contaminated materials shall be disposed of as hazardous waste.	
6.2.7.3	errect me	E seal, P/N B12879-02-01 for damage that could results of the pyro shock or vibration tests. IIL-G-4343 grease.	y /
	Seal dam	aged? yes no	
	Decription	of damage:	
N		Extreme care must be taken when installing the seal. Notice there is a small and large lip on the seal (see Fig. 5, Appendix C). The larger lip is the seal aft face, and the smaller lip is the seal outside diameter.	
6.2.7.4	INSTALL Reference	seal, P/N B12879-02-01 on the exit cone of the motor. drawing B14036.	/

4-20-93

CAUTION: When using thread compound, personnel shall wear neoprene-Latex gloves. Contaminated materials

shall be disposed of as hazardous waste.

COAT fourteen (14) screws (NAS1101E08H10) with MIL-T-83483 6.2.7.5

CAUTION: When installing the Aero Heat Shield, personnel shall be extremely careful not to drop any foreign object into the rocket motor (watches, rings, and other jewelry shall

be removed; eye glasses shall be tethered if worn).

With the nozzle cant vertically up, a properly grounded operator 6.2.7.6 will INSTALL the aeroheat shield cover with the hinge on the left or right side when aft looking forward as specified by USBI/CSD. Proper alignment in either position is provided by a positioning

(NOTE: DO NOT lockwire the screws.)

6.2.7.7 INSTALL the 14 screws and TORQUE the fasteners using a standard cross pattern. Record the torque values.

First Pass: Second Pass:

Finger Tight 10-15 in-lbs

Value:

MSFC QA MSFC QA

Third Pass: Fourth Pass:

20-25 in-lbs 20-25 in-lbs

Value: Value:

MSFC QA MSFC QA

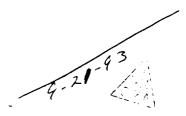
Record SN of torque wrench:

frimer in holes made AHS assembly pery difficult. Priner was removed with but mich and que tips.

6.2.8 Make Sure the Pyro Facility Bay Doors are Open

6.2.9 Clear Area for Test

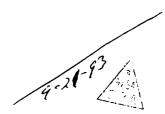
The only personnel allowed in the control room are the pyro shock test conductor, a pyro technician, the MSFC TE, and the MSFC SE (total of four (4) people). All other personnel should move to a clear area. The clear areas are defined as the NORTH hallway of building 4619 and the area outside the pyro control room on the WEST side. Other areas must be cleared with the MSFC TE



6.2.9.0 Conduct Pyro Shock Test to the Following Parameters:

Test Parameters:

	Frequency (Hz) Level	
	50 50 to 100 100 100 100 100 to 4000 4000 to 10,000 24 g peak +12 db/octave 94 g peak +6 db/octave 3750 g peak	
6.2.9.1	1 Turn on the flashing light outside room 170A.	. /
6.2.9.2	For each measurement location select an accelerometer of a testimate to suitable for the amplitude expected.	ype [/
6.2.9.3	Calibrate each accelerometer per ED73-SHK-FOP-008.	
6.2.9.4	Verify test, checkout, and assembly hardware are connected to facility ground system.	the [
6.2.9.5	Verify that no leads are connected to the junction box terminal	/
6.2.9.6	Move junction box switch to "BULB" position.	
6.2.9.7		M
6.2.9.8	Insert the firing key and verify panel meter indicates the correct voltage.	N/
6.2.9.9	Switch key to "ARMED" position and verify power indicator light is illuminated.	[y
6.2.9.10	Open red cover and flip firing switch, verify bulb on junction box lights.	[4]
6.2.9.11	Close red cover.	
6.2.9.12	Switch key to "SAFE" position.	[\]
6.2.9.13	Move junction box switch to "METER" position.	M
6.2.9.14	Switch key to "ARMED" position and verify power indicator light is illuminated.	N N
6.2.9.15	Open red cover and flip the firing switch, verify that the meter on junction box indicates 12 volts.	N

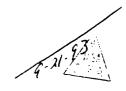


	, ·	V
6.2.9.16	Close red cover.	./
6.2.9.17	Switch key to "SAFE" position and disconnect voltage source.	
6.2.9.18		
6.2.9.19	10 miles of the immediate vicinity (Army Met. 1 eath 670-2405).	
6.2.9.20	in the hazardous area.	N/
6.2.9.21	Verify all non-essential personnel are clear of the test area.	N
6.2.9.22	Verify pyro technician is:	M
	a. Wearing 100% cotton coveralls, shorts, and undershirts.	
	 Wearing safety goggles, hearing protection, and a wrist strap when installing explosive items. 	
	c. In possession of the arming key and that the firing panel is in the safe position.	
6.2.9.23	The pyro technician shall remove all matches, lighters, jewelry, and all battery-powered devices such as electrical wrist watches, calculators, portable radios, etc.	[4]
6.2.9.24	the blocking cons MDF and FISC	M
6.2.9.25	Install required MDF or FLSC on exciter plate. (Total of 26" of ~25 grains per foot) (See Fig. 6 and Fig. 7, Appendix C)	M
6.2.9.26	Verify switch on junction box is in "BULB" position.	M
W .	ARNING: If bulb glows, there is sufficient radio frequency in the area to possibly cause detonation of the blasting cap. The cap should be left shorted and returned to room 170B storage cabinet. All blasting activities will be curtailed until the RF source is removed.	
6.2.9.27	Verify that bulb on junction box is not illuminated.	W
6.2.9.28	In room 170B, verify that blasting cap shorting coil is in place and is undamaged before removing from storage container.	N/
6.2.9.29	2 and transport to room 170	W

6.2.9.30 In room 170, verify		In room 170, verify that wrist straps are in place.	r.x
6.2.9.31 Install blastin		Install blasting cap on exciter plate.	M
6.2.9.32			M
6.2	2.9.34	Remove shorting coil.	
6.2	2.9.35	Move switch on junction box to "METER" position.	M M
6.2	2.9.36	Verify 0 (zero) volts on meter.	M
	337 A		$[\hspace{-0.1cm} \hspace{-0.1cm} -$
201		RNING: If voltage is indicated, the lines to the firing panel are either connected to a voltage source or are picking up voltage from radiation caused by a neasource. The cap should be left shorted and return to room 170B storage cabinet. All blasting activities will be curtailed until the voltage source is removed.	irby ied
0.2.5.37 Move junction box switch to "BIII B" position		M	
6.2.9		Install blasting cap leads in junction box, move switch to "FIRE" position, and remove alligator clip.	M
6.2.9		The pyro technician shall now leave the area, close the door, and inform the MSFC TE of the status.	M
6.3	Det	onation of Pyrotechnics	
6.3.1		lead pyro engineer shall now prepare the data acquisition em to acquire data.	N
6.3.2	Star	t the tape recorder.	
6.3.3	Conr	nect firing lines to the pyro control room junction box.	[M]
6.3.4	The l	lead pyro engineer, the pyro technician, the MSFC TE, and ISFC SE shall now leave the pyro control room and move to lear area outside.	[4]
6.3.5	Conn- verify	ect firing panel voltage supply and insert firing key, that the meter indicates the appropriate voltage.	M
6.3.6 Begin countdown.		M	



	6.3.7	On the count of "3", the pyro technician shall put the switch in the "ARMED" position and verify that the power indicator is illuminated.	M		
	6.3.8	On the FIRE command, the pyro technician will open the red cover and flip the firing switch.	M		
	6.3.9	After firing, turn the firing panel key to the "UNARMED" position.	[~]		
WARNING: If blasting cap does not fire, refer to Section 10.4 in ED73-SHK-FOP-004 (see Appendix A).					
		Blasting Cap Fired: yes no			
	6.3.10	Remove the arming key and disconnect the voltage supply.	[v]		
	6.3.11	Test personnel may now return to the control room.			
	6.3.12	Wait a minimum of 5 minutes after firing before opening the door to room 170.	[6]		
	6.3.13	The lead pyro engineer shall now begin to reduce the data.	FÍ		
	6.4	Post Test Inspection			
	6.4.1	Inform the MSFC TE that the door to room 170 from the control room is to be opened.	[4]		
	6.4.2	The pyro technician shall enter room 170 and move the junction box switch to the "BULB" position.	[4]		
	6.4.3	Remove blasting cap leads from junction box.	[4]		
	6.4.4	Inspect the shock plate to insure all explosive devices fired properly.	14		
	V	ARNING: If all explosive items did not fire, refer to Section 10.5 in ED73-SHK-FOP-004 (see Appendix A).			
	6.4.5	The BSM shall be visually inspected for damage resulting from the pyro shock test. Any anomalies will be recorded. All other personnel shall remain in the control room or in the clear area until the "ALL CLEAR" is given by the MSFC TE.	M		
	6.4.6	MSFC TE indicates all clear for appropriate personnel.			
	6.5	Post Test Removal from the Pyro Plate			



6.5.1	Have a certified fork lift (500 pound minimum) ready to load the BSM and pallet onto the transport truck.		M
	CAUTION:	Exercise care not to entangle or tug on the motor grounding strap during the following lifting operations.	
6.5.2	Tighten the the bolts car	Tighten the lifting straps using the overhead crane so that the bolts can be loosened.	
6.5.3	De-torque ar to the pyro p	nd remove the bolts that attach the brackets late.	
	CAUTION:	The following steps involve working with a suspen load. Keep hands and feet out from under the loa	ided d.
6.5.4	Remove cust vibration tes	com shims and place in labeled bag for use in the ts.	
6.5.5	Lower the motor to waist height.		
6.5.6	Rotate the motor 90 degrees so that the brackets can be mounted on the pallet.		
6.5.7	Using the overhead crane, place the motor on the pallet so that it rests on the aft skirt support brackets and is aligned with the pre-drilled bolt holes.		
6.5.8	With the test item resting on the brackets, unhook the belly straps from the horizontal stabilizing bar.		
6.5.9	Bolt the test item to the pallet using the provided fasteners for transport to vibration.		[4]
	Motor secur	red to palletMSFC TE	
6.6	Test Repor	and Data Requirements	
	will be submit Q=10 value)	eport will be submitted to UT/CSD within 30 working days appleted. Three copies plus one reproducible copy of this relitted containing shock response spectrum (SRS) plots (with and the time history plots. The test tolerances shall be not the control spectrum	port

Model numbers and serial numbers for all instrumentation and test equipment shall be included in the report . Test setup photos should also be included in the report.

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- 7.0 Post Test Verification

The procedure delineated in the above document has been satisfactorily completed and :

- a. All sequences in the procedure have been completed (or deleted by approved deviation)
- b. All Procedure changes have been recorded and approved.

Submitted Verified by:		
D-4	09/2/102	Test Engineer

Date: ___09/2//93

Motor Serial Number: 1000738

9-21-93

BSM MOTOR S/N 1000738 VIBRATION TEST PROCEDURE



George C. Marshall Space Flight Center Marshall Space Flight Center, Alabama 35812

BSM-TCP-EP54-003

BSM Delta Qualification Test

Vibration Tests and Packaging Procedure

This Procedure Describes Safety Critical Operations

BSM Delta Qualification Test

Vibration Tests and Packaging Procedure

Prepared by:

Mat Bevill EP-12

08/16/93

Motor SN: 1000758

Test Date: 09/22/93

Vibration Tests and Packaging Procedure

Prepared by:	Mat Bewill MAST TE/EP12	<u>09/15/93</u> Date
Approved by:	Jim McGee/MSFC Vibration Lab TE	9-14-93 Date
	Jim Herring MSPC Byro Shock Lab TE	9-14-93 Date
;	Richard Leonard/MSFC Safety/CS01	9-16-93 Date
; ; ;	Rick Clements/MSFC Quality/CQ06	9-15-93 Date
	Ben Goldberg Motor Systems Division/EP11	9/14/93 Date
	Stew Bray ster/ Dynamic Test Branch/ED73	9/14/98 Data
•	Charles E. Wells Chuck Wells/UTC/CSD TE	9/16/43 Date
:	Don Wenci/USBI	9-14-23 Deta
	Charlie Lovell/PCH Engineer/CN71	9/16/23 Date

Vibration Tests and Packaging Procedure

Prepared by:	Mat Bewll Mat Bevill/MSFC TE/EP12	<u>09/15/9</u> 3 Date
Approved by:	Jim McGee/MSFC Vibration Lab TE	9-14-93 Date
	Jim Herring/MSFC Tyro Shock Lab TE	9-14-93 Date
	Richard Leonard/MSFC Safety/CS01	9-16-93 Date
	Rick Clements/MSFC Quality/CQ06	<u>9-15-93</u> Date
	Ben Goldberg/Motor Systems Division/EP11	9/14/93 Date
	Steve Breyster/Dynamic Test Branch/ED73	9/14/93 Date
	Chuck Wells/UTC/CSD TE	Date
	Don Wencil/USBI	9-/4-R3 Date
	Charlie Lovell/PCH Engineer/CN71	9/16/23 Date

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1.0 General Information

1.1 Scope

This test procedure addresses all the requirements to perform vibration testing on Booster Separation Motors (BSM). The test program consists of lift-off vibration, boost vibration, and vehicle dynamics vibration.

1.2 Objective

The objective of the dynamic testing is to verify the physical and functional survivability of the Booster Separation Motors. Of particular interest for these tests are the components bonded using EA9394 adhesive. The components using this adhesive include the throat insert, the centering insert, and the igniter grain support rod.

2.0 Applicable Documents

MSFC-STD-513A	Certification of Equipment Operations and Materials Handling Personnel
EG5300.36A	Safety
29 CFR 1910	Occupational Safety and Health Administration
NSS/GO 1740.9	Safety Standard for Lifting Devices and Equipment
NHB 1700.1(V1)	Basic Safety Manual
AMC-R 385-100	Safety Manual
EP01-SOP-01	Standard Operating Procedure for Safety Critical
MM 1700.4	Safety and Environmental Health Hazards
MMI 1700.17	MSFC Procedures for Acquiring Shipping Permits for Rocket Motors and Igniters
MMI 1710.1	Safety Review and Approval of Hazardous and Potentially Hazardous Facilities and Activities at MSFC
MMI 1710.6	MSFC Program for Personnel Certification
MMI 1711.2	Mishap Reporting and Investigation

MMI 1845.1 Hazard Communication Program

MMI 6400.2 Packaging, Handling, and Moving Program Critical

Hardware

MSFC-RQMT-1493 Electrostatic Discharge Control Requirements

MSFC-STD-1800 Electrostatic Discharge (ESD) Control for Propellant and

Explosive Devices

MSFC-STD-126E Inspection, Maintenance, Proof Testing and Certification

of Handling Equipment

CSD-5597-93-1 Rev. B Enhanced Delta Qualification Test Plan for Booster

Separation Motor (BSM), Aug. 6, 1993

10SPC-0067 Rev. A Specification for Booster Separation Motors for Space

Shuttle Solid Rocket Booster (thru SCN 014)

3.0 Safety

3.1 The following safety criteria are in accordance with ET01-SOP-01, Rev. A., Standard Operation Procedures for Safety Critical Operations". If safety rules/regulations are not followed, injury to personnel and/or damage to test items could occur.

Emergency telephone numbers are as follows:

Safety	4-0046
Ambulance	112
Fire	117
Security	4-4357
Utilities	4-3919
Medical Center	4-2390
Communication Repair	4-1771

3.2 Prior to starting work in 4619 a visual inspection of work area shall be made for anomalies by task supervisor and safety personnel.

MSFC TE ______ MSFC SE _______

Date / Time: 09/22/43 5.00 p.n.

3.3 Personnel shall not work or position themselves beneath suspended loads unless such loads are securely and adequately blocked up.

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- Objects handled by overhead hoist shall be lifted only high 3.4 enough to clear fixed objects in the path of travel. Spreader bars and slings may be left on the hoist if desired when not in use, but must be raised so that the lowest part of the lifting equipment will be at least seven feet from the floor when not in
- Crane, hoist, lift prime operators, and riggers shall be certified 3.5 according to the latest revision of MMI 1710.6, and shall have in their possession a valid certification card.

Certifications checked by:

Date / Time:

03/24/93 5:00 pm

- Personnel working around suspended loads shall be alert to 3.6 the possibility of being crushed between the suspended load and a fixed object.
- Loads shall be moved slowly so they will not accumulate more 3.7 momentum than can be stopped with little or no swing. 3.8
- Where handling slings are called out, a sling with more pickup points than required may be used if the weight capacity per point used is equal or greater than the weight capacity of each point of the noted sling and the free pickup point is (are) secured to prevent it (them) from swinging and causing
- Only the area coordinator should direct the crane moves, 3.9 however, any person determining an immediate danger or problem may request stoppage of activities.
- The lifting or transportation operation shall be halted by the 3.10 area coordinator at any time the control area cannot be
- Steel toe shoes are required during lifting operations. Hardhats are required when the lift is at or above the shoulders.
- Tag line operators are to wear leather gloves. 3.12
- The primary safety hazards associated with this operation are: 3.13
 - 3.13.1 Lift operations
 - 3.13.2 Solvent Use (See NOTE)
 - 3.13.3 Live (Loaded) Solid Rocket Motor

NOTE: Grease and solvent use are only "if needed" as determined by the MSFC TE and CSD TE.

- 3.14 Any time a crane is being used, it must be dogged if:
- 3.14.1 The load will be suspended in a static condition for an extended amount of time.
- 3.14.2 A crane operator crew change or substitution must be made.
- 3.15 No electric power tools shall be used near the live test item.
 Use of pneumatic tools is acceptable.
- 3.16 All ground cables and ground straps end-to-end resistances shall be verified with a multimeter. These resistances must measure less than 1 ohm.
- 3.17 All personnel within touching distance shall wear a wrist strap that has been checked with a wrist strap checker. This step should be performed each time the wrist strap ground is broken.
- 3.18 All personnel within touching distance of open grain propellant (and ordnance) shall wear antistatic coveralls.

.0 Test Items and Test Requirements

4.1 Test Items

The test item for the vibration tests consist of a BSM which will be tested in the aft motor configuration. The motor will be tested with an aero heat shield over the exit cone. The motor weighs approximately 154 pounds.

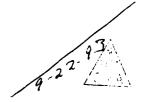
Motor Serial Number 1000738 Conditioning Temp. 125° -0 F

4.2 Test Requirements

4.2.1 Test Tolerances

The tolerances applicable to the test conditions are as follows: (Unless otherwise stated in the procedure)

·	± 5%
Vibration Frequency:	+10%, -0%
Test Duration:	± 5° F
Temperature:	±10%
Sinusoidal Control Signal	
Maximum Harmonic Distortion	+20%, -10%
Sinusoidal Peak Acceleration	,



Composite Root Mean Square Acceleration

±10%

Acceleration Spectral Density

+100%, -25% (+3dB, -1.5dB)

4.2.2 Test Data

All data taken with non-recording instruments will be recorded in ink directly onto data sheets and/or log sheets. The log or data sheets will identify the test being performed, the test item, the item part number, and the applicable test procedure. Corrections or changes will be made by drawing a single line through the original entry. The new entry will be made directly above the old and initialed by the person making the entry. Each page will be signed and dated at the bottom of the page by the person making the entries, and counter signed by the test engineer after review.

4.3 Test Conditions

The live delta qualification motor will be vibration tested at a specific temperature. The motor will either be tested at 25°F (+0, -5°F) or at 125°F (+5, -0°F) depending on which qualification motor this procedure controls.

4.3.1 The MSFC TE shall check with the Army MET team to ensure that there is no lighting within 10 miles.

(MET team phone number....876-2465).

[4

- 4.3.1.1 If lightning is within 10 miles during any time that a live BSM is in building 4619, the MSFC TE shall make arrangements to disconnect the motor ground from the facility ground. The motor shall remain ungrounded until the lightning is out of range.
- 4.3.1.2 When reconnecting the ground after a lightning storm, a 100Kohm resistor should be connected to the ground wire from the motor before connecting to facility ground. This allows any charge on the motor to slowly dissipate to ground. The resistor should be left connected for no less than 30 seconds.
- 4.3.1.3 After the specified time, disconnect the ground wire from facility ground and remove the resistor. Reconnect the ground strap from the motor to facility ground.

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The test site's relative humidity must be above 20%. If the humidity 4.3.2 is below 20%, all test operations must cease until favorable weather

Test site's relative humidity 37 % MSFC TE MB

- Test Equipment 4.4
- All measurements shall be made with instruments and equipment whose accuracy and/or calibration has been

Calibration Acceptable MSFC TE
CSD TE

- 4.4.2 Proof Loading of Handling Equipment (required for PCH)
- 4.4.2.1 The heaviest lift during all of the delta qualification testing will be lifting the motor while in its shipping container. The motor and shipping container together weigh about 310 lbs. All forklifts and overhead hoists must be load (break) tested to at least 110% of this weight (i.e. 350 lbs.). This test must be performed prior to any handling of the BSM but does not need to be repeated until something other than the BSM is lifted by the same handling equipment. It is therefore recommended that the break tests be performed each evening before the BSM testing commences. The break tests shall be performed as follows:
 - The proof load must be at least 350 lbs. a.
 - Lift the dummy load clear of the ground (less than 1 foot) and lower to ground three times, holding for five minutes on the third lift. Lifting straps and spreader bar should be attached

SEE APPENDIX C FOR THE PROOF TEST INSPECTION SHEETS.

- **Test Procedure** 4.5
- After review and documented approval, a redline change to this procedure may be performed. Approval shall be by a minimum of the MSFC TE, MSFC QA, and MSFC SE.
- As soon as possible after a test failure, a deviation from the specified test environment, or any other incident which affects the test or test item, MSFC will notify the authorized UT/CSD representative of the event verbally and will then generate a Test Procedure Deviation (NASA form 3959). A copy of the Test

Procedure Deviation is presented in Appendix A. Photographs of any discrepancies shall also be taken.

Personnel Responsibilities 5.0

5.1

CLAN	Calculation of the Control of the Co	
1	Test Witnessing	
	All tests will be witnessed by the authorized UT/CSD representative and USBI representative. The MSFC test engineer will also witness the testing. Notification of the start of each test shall be communicated to the authorized UT/CSD of each test shall be communicated to the authorized UT/CSD and USBI representatives and the MSFC safety representative and test engineer at least 2 hours in advance.	
	MSFC Safety Notified	
	UT/CSD Notified	
5.2	The MSFC TE will serve as the area coordinator for the test. All handling of the BSM will be directed by the MSFC TE or cognizant test engineer.	
5.3	shall be responsible for	/
5.4		3
5.5	prior to testing. The area around the outside of the vibration facility shall be The area around the outside of the vibration facility shall be secured before the live BSM is brought to the pyro shock test site.	
	Area secured? YES NO MSFC SE	
	Comments: does butted, recurry tape up.	
Y	7ibration Tests 5.0.1 Make sure the CSD TE has reviewed the calibrations for the	14
		M
6	6.0.2 Open the doors that enter the vibration test room from the	./

<u>Vib</u> 6.0

high bay of bldg. 4619.

Re-check system setup. Verify chamber temperature. 6.1

- 6.2 Radial Axis Tests
- 6.2.1 Assemble the leg supports on the conditioning chamber.

[4]

- 6.2.2 Lift Off Vibration
- 6.2.2.1 The following levels and conditions apply for the lift off vibration tests. Vibrate the motor only as follows for a duration of 60 seconds:

Frequence (TT.)		on or ou seconds:
20 20 to 55 55 to 200 200 to 280 280 to 1200 1200 to 2000 2000	Level 0.017 g ² /Hz +6 db/octave 0.077 g ² /Hz -11 db/octave 0.022 g ² /Hz -4.5 db/octave 0.010 g ² /Hz	See Deviation #2

Composite: 6.9 grms

- 6.2.3 Boost Vibration
- 6.2.3.1 The following levels and conditions apply for the boost vibration tests. Vibrate the motor only as follows for a duration of 120 seconds:

1

Frequency (Hz)	Level	See Devia
20 to 200 200 to 350 350 to 1000 1000 to 2000 2000	$0.54 \text{ g}^2/\text{Hz}$ -12 db/octave $0.060 \text{ g}^2/\text{Hz}$ -6 db/octave $0.015 \text{ g}^2/\text{Hz}$	#1

Composite: 14.0 grms

- 6.2.4 Vehicle Dynamics Vibration
- 6.2.4.1 The following levels and conditions apply for the vehicle dynamics tests. Vibrate the motor only as follows:

[4

Frequency (Hz)	Level
5 to 10	0.7 g peak
10 to 40	3.7 g peak

Sweep Rate: 3 octaves per minute

9-22-93

Redline for the repeat of these steps after Deviations 1 and 2 Transport Motor From Room 156 to Room 158/ Setup for Tang. Axis 6.3 Remove leg supports from conditioning chamber. 6.3.1 6.3.2 Disconnect the conditioning unit from the conditioning chamber. 6.3.3 Inspection certifications shall be provided for the overhead Crane #1, Bldg. 4619 rm. 156 certification provided _______ Crane #2, Bldg. 4619 rm. 158 certification provided (158) 6.3.4 Certifications for all lifting fixtures shall be provided: Lifting beam assembly certification provided_ Lifting rings (D-rings) Be careful not to disconnect the motor ground CAUTION: The following step involves working with a suspended load. Keep feet and hands out from under the load. Using the overhead crane, lift the conditioning chamber off of the vibration table and place it on the floor. Record time when chamber was removed 6:42 pm. 7:30 p.m. 6.3.6 Verify motor ground connection on the motor and at the facility Disconnect the instrumentation wires. Remove any other instrumentation that is no longer needed or that might interfere Attach the lifting straps (as shown in Fig. 1a) to the motor

Remove of the straps (as shown in Fig. 1a) to the motor

Remove of the straps (as shown in Fig. 1a) to the motor 6.3.9 Remove adapter plate to vibration table fasteners. CAUTION: Be careful not to disconnect the motor ground CAUTION: The following step involves working with a suspended load. Keep feet and hands out from under the load.

4-22.43

6.3.	roll cart.	a
6.3.1	Unhook spreader bar from lifting straps. Leave straps	2-93 swrapped [U
6.3.1	Open the doors that enter the high bay in room 158.	Ŋ
	CAUTION: Make sure that the ground strap is long reach to room 158 during the transport to the other.	enough to from one room
6.3.1	Be sure to place the cart directly beneath the	
6.3.14		F-22-93 crane. [y]
	CAUTION: Be careful not to disconnect the motor while lifting.	ground
l	CAUTION: The following step involves working wit load. Keep feet and hands out from und	h a suspended ler the load.
6.3.15		art [V
6.3.16	Align the adapter plates with the holes on the table.	[4]
6.3.17	7 Fasten the adapter plates to the table using the facility s fasteners. Torque these fasteners to 65 ft-lbs.	supplied [V]
	Record torque value: 65 ft - 165 MSFC QA	_
	Torque wrench SN: BTW-ZRCF	
6.3.18	Remove all lifting hardware.	M
6.3.19	Attach accelerometers to the motor (see Fig. 2)	(,)
6.3.20	Reconnect accelerometer wires.	[1]
6.4	Thermal Conditioning Setup for Tangential and La	
6.4.1	Use the overhead crane to place the conditioning chamber of the motor.	over [v]
6.4.2	Once the chamber is in place, attach the necessary hoses are instrumentation from the conditioning unit to the chamber	nd [Y



6.4.3	Make sure the chamber to for measuring the air ten	hermocouple is in the correct position apperature around the motor.	N
6.4.4	Make sure the motor grow	und strap is secured.	[4]
6.4.5	Activate conditioning unit has stabilized to the desir	t and monitor the temperature until it red temperature.	[4]
	Record time/temp. when s Record total time out of co	ortabilized: 8 30 p.m.	
6.4.6	Recondition motor for twice than 30 minutes.	ce the time out of conditioning if out more	M
	Reconditioning necessary: If yes, how long does motor	Yes No pr need reconditioned? 2 hrs	
6.5	Tangential Axis Tests		
6.5.1	Lift Off Vibration		
6.5.1.1	5.1.1 The following levels and conditions apply for the lift off vibration tests. Vibrate the motor only as follows for a duration of 60 seconds		M
	Frequency (Hz)	Level	
	20 20 to 75 75 to 1000 1000 to 2000 2000	$0.016 \text{ g}^2/\text{Hz}$ +3 db/octave $0.060 \text{ g}^2/\text{Hz}$ -3 db/octave $0.030 \text{ g}^2/\text{Hz}$	
	Composit	a. 10.0 ama	

6.5.2 Boost Vibration

6.5.2.1 The following levels and conditions apply for the boost vibration tests. Vibrate the motor only as follows for a duration of 120 seconds.

Frequency (Hz)	Level
20 to 800 800 to 2000	0.24 g ² /Hz -4 db/octave
2000	-4 divoctave 0.071 g ² /Hz

Composite: 18.4 grms

9.22-93

6.5	.3 Vehicle	Dynamics			
6.5.	.3.1 The fol	lowing levels and co Vibrate the motor on	nditions apply for the vehicle dynamics	M	
	Free	luency (Hz)	Level		
		to 10 0 to 40	0.7 g peak 4.3 g peak		
		Sweep Rate: 3 octa	aves per minute		
6.6	Axis Ch	ange From Tange	ntial to Longitudinal		
6.6.1			from conditioning chamber.	6.2	
6.6.2	Attach ov	erhead crane to the	conditioning chamber.	(y'	
6.6.3	Slowly lift away and	the conditioning be-	off of the test item and move it	[4]	
₹ 6.6.4	Record time for the bound for the bound con	te of chamber removed to meter fasteners or ground connection tact point.	al: 11:00 pm. Pay 9-22-9 torque checked OK 12:93 n on the motor and at the facility	[Y	
6.6.5	Remove ad	apter plate to vibrati	on table fasteners.	5.3	
6.6.6		ntrol accelerometer.		[V]	
C	CAUTION:	Be careful not to changing the axi	disconnect the ground when son the table.	(A)	
		The following stelload. Keep feet	ep involves working with a suspend and hands out from under the load	led	
6.6.7	Rotate the r Disconnect	notor and bracket as lifting hardware.	sembly 90° using the overhead crane.	[Y	
6.6.8	Re-attach ac Torque to 65	lapter plate to vibrat ft-lbs.	ion table fasteners.	[4	
I	Record torque value: 45 ft-165 MSFC QA _ PC				
7	Torque wrend	th SN: BTW-ZRCF			
6.6.9 F	Reconnect co	ontrol accelerometer		W	

9.22-93

6.6.10	Reconnect lifting hardware to the conditioning chamber and place it over the motor. Reconnect chamber legs as necessary.		
6.6.11	If necessary, re-attach hoses, instrumentation, etc., before starting conditioning unit.		
6.6.12	Start conditioning unit. Monitor undesired temperature.	ntil it has stabilized to the	U
	Record time/temp. when stabilized: Record total time out of tolerance:	11:26 76 min	/
6.6.13	Recondition motor for twice the tin out was greater than 30 minutes.	ne out of tolerance if the time	
	Reconditioning necessary: Yes (If Yes, how long does the motor ne	No ed reconditioning?	
6.7	Longitudinal Axis Test		
6.7.1	Lift Off Vibration		/
6.7.1.1	The following levels and conditions test. Vibrate the motor only as follows:	apply for the lift off vibration ows for a duration of 60 seconds.	W
	Frequency (Hz)	Level	
	20 20 to 75 75 to 1000 1000 to 2000 2000	0.016 g ² /Hz +3 db/octave 0.060 g ² /Hz -3 db/octave 0.030 g ² /Hz	
	Composite: 10.0 g	rms	
6.7.2	Boost Vibration		_
6.7.2.1 The following levels and conditions apply for the boost vibration test. Vibrate the motor only as follows for a duration of 120 seconds.			[J]
	Frequency (Hz)	Level	
	20 to 800 800 to 2000 2000	0.24 g ² /Hz -4 db/octave 0.071 g ² /Hz	

Composite: 18.4 grms

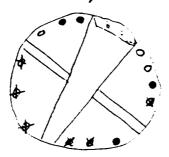
CONDITIONS TO POST TEST INSPECTION (6.8)

LOSSE AERO HEAT SHIELD BELTS

O-LOSE BOLTS (QTY 4)

O-LOSE BOLTS (QTY 3)

O-OKAY



						4		
,	_	6.7.		Dynamics				
		6.7.3	3.1 The fol test. V	lowing levels a ibrate the mote	and condit or only as	ions apply for follows.	the vehicle dynamic	s [v
			Free	mency (Hz)		Level		
			5 1	to 10 0 to 40		0.7 g peak 4.3 g peak		
				Sweep Rate:	3 octaves	per minute		
	6	8.8	Post Tes	Inspection		Por minute		
	6	.8.1	The BSM : MSFC TE vibration :	test item shall is, and the CSD testing.	be visuall: TE for ex	y inspected by terior damage	~4411/ *	[4]
	6.8	8.2	Remove all	instrumentati	ion.	No dunage 1	0 ted.	
	6.9			uirements				[X
70		p a	lots. Accel cceleromet	eration versus ers used during	erplotted (frequency g vehicle	for all control a tests shall be re on the control a plots shall be dynamics tests	corded. The	
7.0	Pos	t Te	est Disass	embly/Prepar	e for Sh	inmont	•	
	7.1	C	onditioni	ng Chamber	Remova	l pueur		
	7.1.1	Di th	sconnect a e removal (ny hoses and in of the chamber.	nstrumen	tation that hin	ders	(1.2 /
	7.1.2	Us off	ing the ove of the vibra	erhead crane, s ation table and	lowly lift place on 1	the conditionir	ng chamber	[V]
	7.1.3	Mo	ve chambe	out of the way	7.	-100F.		[4]
	7.1.4					vay if necessar		
	7.1.5	Ver.	ify motor g ind contact	round connecti	on on the	motor and at t	y. The facility	M
	7.1.6			on table insula			· *	[~]
								[4]



7.2	Aero Heat Shield Removal			
	WARNING: Removing the Aero Heat Shield exposes the motor's propellant grain. Personnel should use caution durany operations with and exposed grain. Tools, watches, eye glasses, etc., should be tethered (if necessary) to prevent dropping anything into the motor.	ring		
7.2.1	Make sure the motor ground is secured.			
7.2.2	Make sure verified wrist straps are being worn by the personnel removing the aero heat shield.	M		
7.2.3	Remove the fasteners from the Aero Heat Shield. Place the fasteners in a marked bag.	M		
7.2.3	SLOWLY remove the Aero Heat Shield.	IJ		
7.2.5	Remove the heat shield seal. Do not drop the seal into the motor.			
7.3	Post Test Inspection of Motor Propellant Grain			
7.3.1	Make sure motor ground wire is secured.	[4]		
7.3.2	Clear area of all non-essential personnel. Only the grain inspectors (2) and the MSFC TE shall remain.			
7.3.3	Verify grain inspector(s) is(are):	[4]		
	a. Wearing 100% cotton coveralls, shorts, and undershirts.			
	b. Wearing a wrist strap.			
	c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.			
7.3.4	Perform grain inspection.	[4]		
	Cracked propellant yes no			
	If yes, give approximate location and size of crack:			

7.2



	Other comments on grain condition:			
	Noe	DEFERENCES NICTED FROM PRE-TOST IN-FECTIONS		
7.3.5	Grain insp MSFC QA A draw-wi	ire, fabric, security bag shall be in a line.		
	nozzle exicand security le security le was receiv	t cone. The bag shall be closed around the exit cone ed by inserting the bag wire ends through a standard / R ad-seal (i.e. cover the exit cone the same way that it put).	[v] v4/23/43 -23-93	
7.4	Adapter	Plate Removal	?3.93	
7.4.1	Remove th	e adapter plate to vibration table fasteners.	5.	
7.4.2		ng straps as shown in Fig. 1b (Appendix B).	[4]	
		Be careful not to disconnect the ground while lifting the motor.	[4]	
C	CAUTION:	The following step involves working with a suspe load. Keep hands and feet out from under the lo	ended ad.	
7.4.3	Lift the mornear the wo	tor off of the vibration table and move to an area	M	
7.4.4	Lower the r	notor so that it rests on the wood supports.	[A]	
		notor 180° so that the adapter plates face up.	()	
7.4.6		bracket to adapter plate fasteners. Place Cont	[4]	
C.	AUTION:	Be careful not to disconnect the ground while lifting the motor.		
C	AUTION:	The following step involves working with a susper load. Keep hands and feet out from under the los	aded ad.	
7.5 A	Aft Skirt B	racket Removal	· 	
7.5.1 F	Remove the a	aft end motor to bracket fasteners (12 places). ers in a marked bag. ¥	M	
`}	LIGHT S	ACKET ATTACHMENTS. JH 9/23/93 DC 9-21-93		
		122 MB 9-23-93 Pays 4-23-93	2.93	

4.23

CHATTER MARKS EVIDENOT ON MS (4/13/9)
FORWARD FACE OF THE MOTOR. SH 4/12/93

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		CAUTION:	The following step involves working with a suspendoad. Keep hands and feet out from under the load	ded l.
	7.5.2	Lift the mot	or to waist height using the overhead crane.	W
	7.5.3		notor 180° so that the bracket to adapter plate es face the floor.	[N
	7.5.4	Lower the n	notor so that it rests on the wood supports.	W
	7.5.5		ward end motor to bracket fasteners (8 places). hers in a marked bag.	[1
3.0	Ret	urn Motor to	the Vertical Position	
	8.1		rings, 180 degrees apart, and one lifting strap d holes of the motor.	W
	8.2		break-over" brackets (and lifting strap) to the bolt holes on the forward face of the motor case.	M
	8.3	Attach the a	off lifting strap to the overhead crane hook.	[U
		CAUTION:	The following steps involve working with a suspend load. Keep hands and feet out from under the load	
		CAUTION:	Be careful not to disconnect the ground while lifting the motor.	
	8.4	strap on the	(as chosen by the MSFC TE) shall hold the lifting forward end to keep the motor from swinging when he aft end. Slowly lift the aft end of the motor to bring al position.	W
	8.5	Raise the m	otor so that the aft end is at waist height.	W
		CAUTION:	The following steps involve working with a suspendoad. Keep hands and feet out from under the load	
	8.6	Disconnect to marked bag	the "break-over" brackets. Place brackets in a	N

CAUTION: Be careful not to disconnect the ground while lifting the motor.



9.0 Place Motor In Shipping Container

9	Remove lid from shipping container by removing the lock-ring bolt and nut, lockring, and cover. (See Fig. 3 for an overall view of the shipping container).	M
9	Remove top cushion insert. Make sure that the top bearing plate is properly oriented to the relative location of the drum humidity indicator/pressure relief valve (see Fig. 4). If not as shown (the two 1-inch dia. clearance holes must straddle the (imaginary) horizontal center line) the center cushion insert, as a unit (do not to bring the top plate into proper position as shown.	14
9.3	tie rod nuts.	W
9.4	Remove and discard any old bags of desiccant.	_
9.5	Drape the loose end of the container ground strap over the edge of the container.	M
9.6	Visually inspect the container interior to assure it is free of any foreign matter. Vacuum interior if required.	W
9.7	Attach a ground wire to facility ground and verify its resistance. Resistance shall measure less than one (1) ohm.	W
	Resistance measured: MSFC QA	
9.8	Connect this ground wire to the motor shipping container and verify the resistance (<1 ohm)	[J
	Resistance measured: MSFC QA	
9.9	Install the antistatic foamed plastic liner tightly around the motor case, and secure in place by taping the liner's vertical butt-joint (trim as required) using 2" wide tape. It 9-23-93 Reg-23-93 Reg-23-93 Install the antistatic plastic film bag, up and over the motor.	M
9.10	Install the antistatic plastic film bag, up and over the motor.	
9.11	Visually orientate the motor nozzle cant to the side of the container indicated by the marking, "POSITION NOZZLE CANT THIS SIDE"	W W
C	ATIMYON	

CAUTION: Be careful not to disconnect the motor ground while lowering the motor into the container.

9-23-93

CAUTION: The following steps involve working with a suspended load. Keep hands and feet out from under the load. CAUTION:

When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and

After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovol. When the reading is below 1.0 kilovolt, removal operations may continue.

If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect

larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety, and evacuate all personnel to safe locations.

9.1	2 Slowly lower the mo'or into the container while monitoring static charge.	ify ons.
	Record Stat Gun SN: C 10459	14
9.13	CAUTION: Make new ground before brooking	¥
9.14 9.15	Resistance Measured MSFC QA	[V]

9.16	by the marki NOZZLE CA bring it to re to 20 in-lbs 1	ntate the top bearing plate to the nozzle cant, indicated ing on the plate "POSITION THIS SIDE TO THE NT", and place it over the nozzle and three tie rods and est on the motor flange. Tighten and torque tie rod nuts 2 in-lbs. e value:	4
	Record torqu	e value: wish of	
	Torque wren	ch SN: <u>5492304</u>	
	CAUTION:	Make sure that the top bearing plate is indexed to the motor case O.D. and is resting flat on the top of the flange.	
		Also, make sure that the grounding strap terminal and attach nut and bolt head is positioned in the clearance hole in the plate.	
9.17	Place twelv container in	e (12) 16 unit size bags of fresh desiccant into the a the cavity around the top bearing plate.	[1]
	CAUTION:	Once the bagged desiccant has been put into the container, the remaining packaging steps must be completed immediately and the container closed to prevent the desiccant from over exposure to free air circulation.	
		If, after the desiccant has been placed into the container, the packaging cannot be completed, close the container until packaging can be resumed	•
9.18	the bottom plate.	top cushion insert. Make sure that its index slot, on face, matches with the index block on the top bearing	
9.19	into a suit Richmond	motor log book and any other required documentation able size electrostatic free plastic bag (3M velostat or Pink Poly) and place into the stowage slot provided cushion insert.	18 01/2/4 1284-25-9 169-23-9
9.2	is no fo r ei	container lid onto the container, making sure that there gn matter on the lid gasket or container rim.	M
9.2		e lockring, with its bolt flanges positioned (centered) he container humidity indicator and lifting grip. e bolt and nut and torque to 6 ft-lbs ± 1/2 ft-lbs (72 in-lbs).	[4]

Record torque value: 6 f4-155 MSFC QA CC

Torque wrench SN: 5492304

NOTE: The lockring shall be tapped, using a rubber mallet, at various points around the ring during bolt tightening.

Install a standard wire and lead seal through the provided holes 9.22 in the lockring bolt flanges. Secure using a QC press die engraved. with UTC & No. - M 24 LU143, 1989-23-93

NOTE: Before shipping, USBI personnel shall make sure the shipping container is properly labeled. Reference CSD's Material Handling Card, Rev. C, dated 5-23-89 sections 10 and subsequent.

Test Report 10.0

A final test report will be submitted to UT/CSD within 30 working days after testing is completed. Three copies plus one reproducible copy of this report will be submitted containing the following information as a minimum:

- A. A description of test mounting and setup and location of instrumentation with two sets of color still photographs (8-1/2 by 11 inches) of setups and instrumentation close-ups.
- B. A list of all instrumentation and equipment with ranges and plot accuracy of all acquired data with objective evidence of calibration status at the time of tests.
- C. Sketches of test setups.
- D. Power spectral density (PSD) plots of all acceleration data.
- E. The results of all inspections and tests performed i.e., data tapes, data plots, and completed data summary sheets.
- F. Any alteration or deviation from this procedure will be described in detail by a Notice of Deviation and included in the final report.
- G. Model numbers and serial numbers for all instrumentation and test equipment shall be included in the report.

ľ

11.0 Post Test Verification

The procedure delineated in the above document has been satisfactorily completed and :

- a. All sequences in the procedure have been completed (or
 b. All Procedure
- b. All Procedure changes have been recorded and approved.

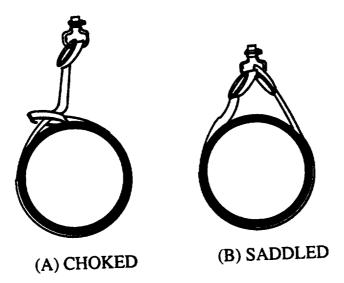
Submi	tted Verified by:	THE POLICE WI
Data	acholos	Test Engineer

Date: 09/23/93

9-23-93

Appendix B

Figures



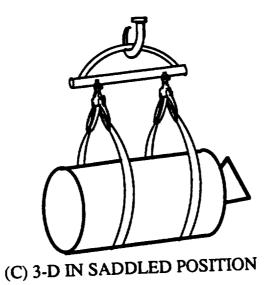


FIGURE 1. LIFTING STRAP ATTACHMENTS

DRAWN BY: K. MITCHELL/EPS4 3/4/93

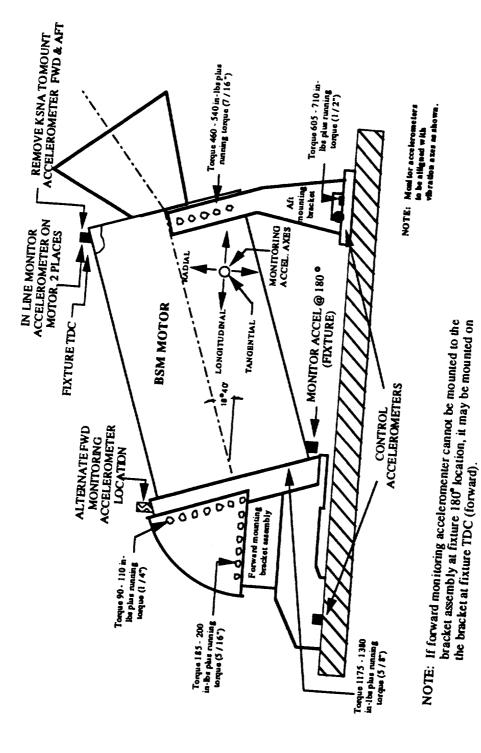


FIGURE 2. VIBRATION TEST SETUP

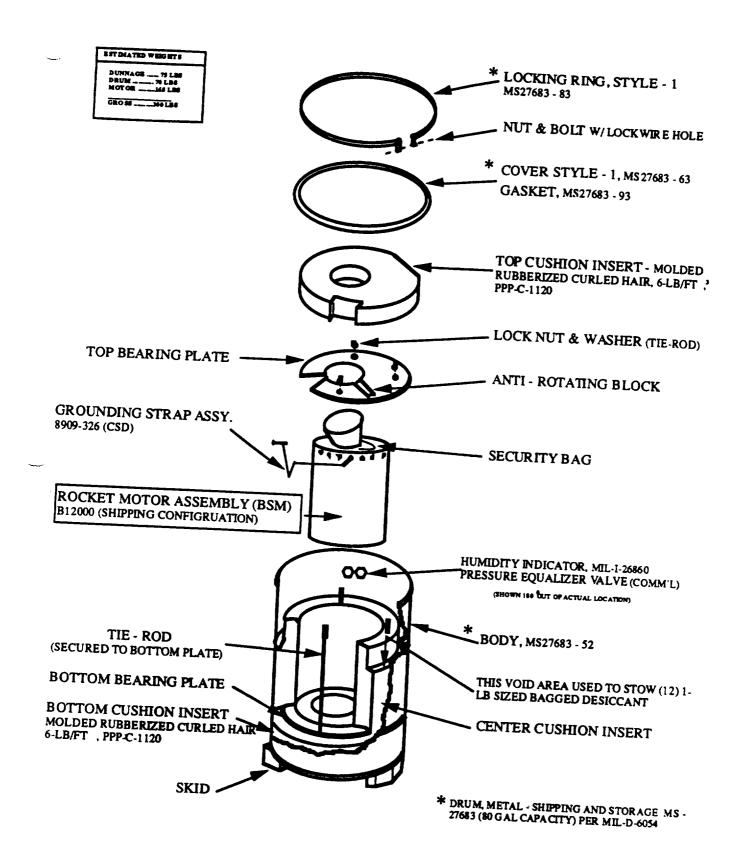
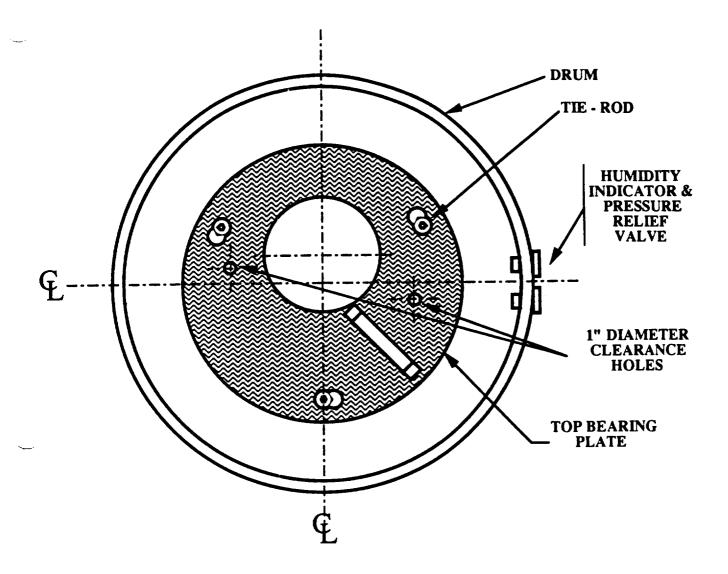


FIGURE 3. OVERALL VIEW OF SHIPPING CONTAINER



VIEW LOOKING DOWN AT OPEN DRUM

FIGURE 4. Top View of Shipping Container

DRAWN BY: K.MITCHELL/EPS

BSM MOTORS S/N 1000734 AND S/N 1000738 PYROSHOCK TEST DATA

National Aeronautics and Space Administration

George C. Marshall Space Flight Center Marshall Space Flight Center, AL 35812



o Attn of: ED73 (93-94)

October 6, 1993

TO:

EE11/Mr. Smith

FROM:

ED73/Mr. Brewster

SUBJECT:

SRB Booster Separation Motor (BSM) Pyrotechnic Shock Qualification Test TCP# SRB-QUAL-ED93-062

Pyrotechnic Shock Qualification tests were completed on two BSM flight units on September 20-21, 1993 at the MSFC pyrotechnic Shock Test Facility in building 4619. The tests were necessary to flight qualify various BSM hardware modifications. Test 1 was completed on BSM Unit SN 1000738 and test 2 was completed on BSM Unit SN 1000734. The tests were conducted according to BSM Delta Qualification Test Procedure #BSM-TCP-EP54001, dated

The test setup consisted of hanging a 4' X 8' X 1/2" steel plate from the ceiling of the blast room and mounting the BSM horizontally approximately in the middle of the plate with the thrust direction pointed to the blast room away from the door. The test setup is shown in enclosure 1 and the photographs in appendix A.

The pyrotechnic shock was generated by two #8 blasting caps and 20 inches of Flexible Linear Shape Charge (FLSC) (25 grains/foot) configured in two parts around each end of a two 3/8" X 2" thick steel bar and another #8 blasting cap and 6 were installed on the opposite side of the plate from the BSM.

The instrumentation consisted of four 4 triaxial accelerometer configurations located in close proximity to the 4 BSM mounting feet. Each triaxial cluster was sensitive to the 3 orthogonal axes, horizontal, vertical, and normal to the panel. The accelerometers were calibrated according to Document #ED73-SHK-FOP-008, entitled "Facility Operating Procedure for calibration of Accelerometers used in Shock Tests," dated acquisition and analysis equipment is shown in enclosure 3.

The calibration dates of pertinent hardware is shown in enclosure 4. At least one measurement point in the horizontal, vertical, and normal direction from the four accelerometer locations was required to meet the shock specification test criteria.

The test data is enclosed in appendix B. The first plot is a time history of the real time shock recorded over a 25 milisecond interval and the units are G peak versus time. The second plot is a Shock Response Spectrum (SRS) analysis computed over the frequency band from 50 to 10,000 Hertz and its units are G's versus frequency. The SRS analysis is completed on both positive and negative data points and both curves are on the plot. The specification and tolerances have been added to the plots.

A deviation was issued against the response data being higher than the allowed +6db tolerance level for all axes. These exceedances were in most cases not significantly higher than the allowable tolerance and occurred in narrow bandwidths. Nevertheless, these exceedances were impossible to eliminate. The deviation is enclosed in appendix C.

Steve R. Brewster

Chief, Dynamics Test Branch

Enclosure

cc:

CS01/Richard Leonard

ED13/Roy Winkle

ED23/Robin Ferebee

ED71/Gerald Waggoner - w/o encl.

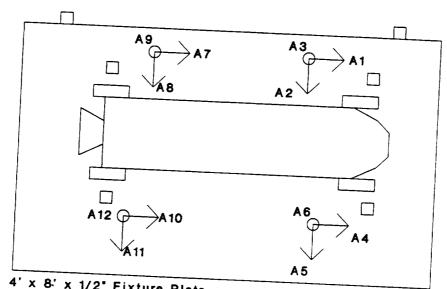
ED73/Jim Herring

ED73/File Copy

EP54/Jim Niblett

EP54/Matt Bevill (3 copies)

USBI/Don Wencil

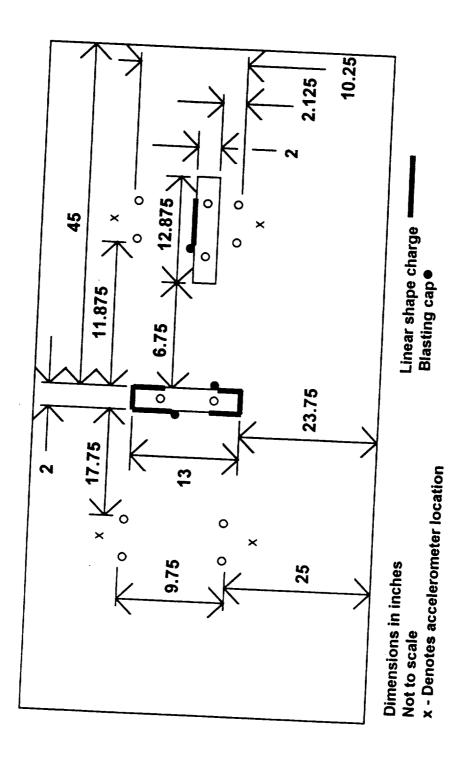


4' x 8' x 1/2" Fixture Plate

BSM Pyroshock Test Setup Front View

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BSM Pyroshock Test Setup



Data Acquisition / Analysis System

<u>ITEM</u>	MFG	Model	# Reg'd
Accelerometer	Endevco	2225M5A	12
Shock amplifier	Endevco	2740B	12
FM Tape Recorder	DataTape	3700Ј	1
Shock Analyzer	GenRad	2518	1

SHOCK AMPLIFIER CALIBRATION, MODEL 2740B

S/N	DUE DATE
FT80	1/22/94
FT73	12/25/93
FT77	12/29/93
FT74	12/25/93
FT75	12/25/93
FK21	12/28/93
FT72	10/21/93
FJ05	12/29/93
GB75	12/24/93
GB72	12/29/93
GB73	12/29/93
GB69	12/24/93

SHOCK ACCELEROMETER CALIBRATION, MODEL 2225M5A

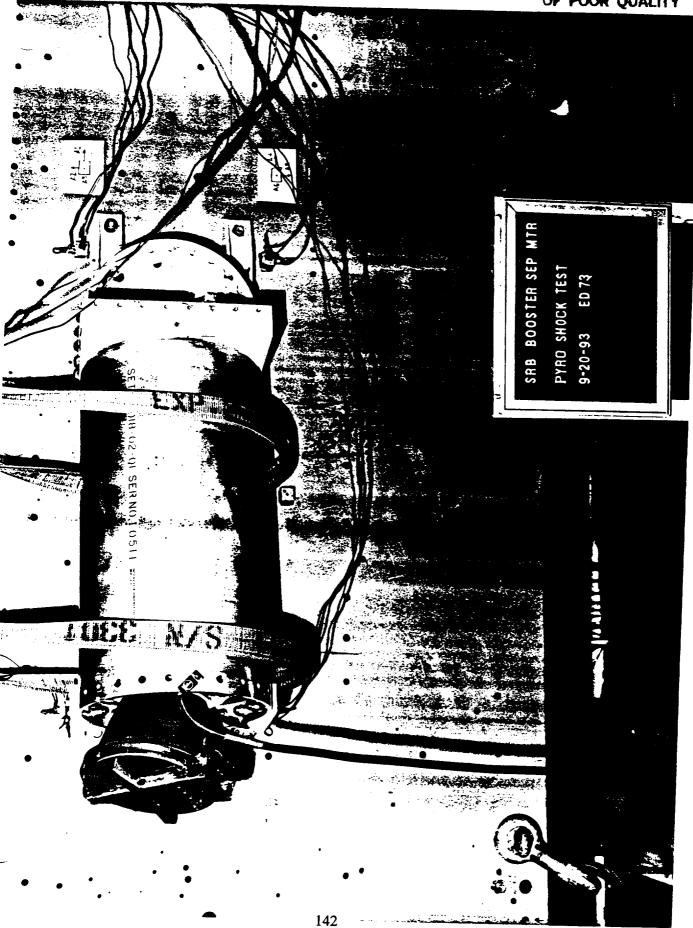
S/N	DATE
GN25	8/20/93
GN36	8/20/93
GM66	8/20/93
GM67	8/20/93
NW66	8/20/93
A09H	8/20/93
A22H	8/20/93
A26H	8/20/93
A33H	8/20/93
A42H	8/20/93
A91D	8/20/93
A93G	8/20/93

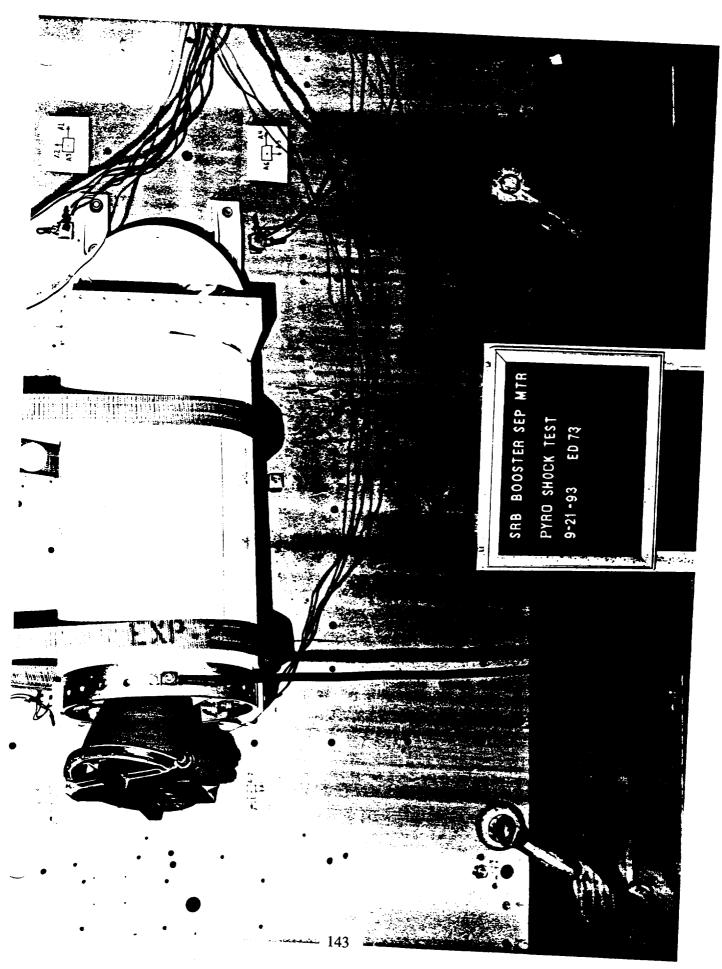
STANDARD ACCELEROMETER CALIBRATION, MODEL 2270

S/N DUE DATE SA04 8/31/93

Appendix A Photographs

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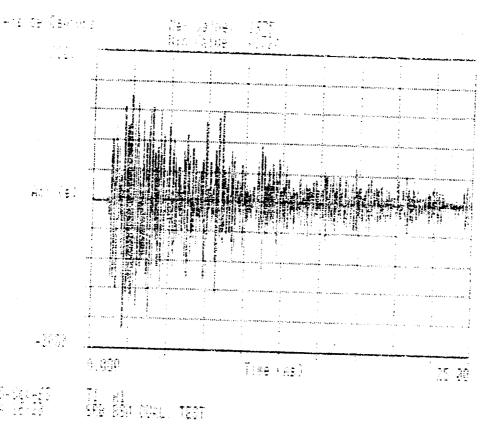




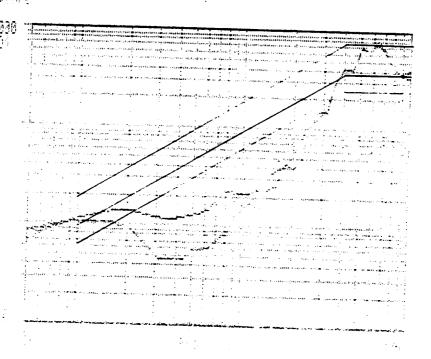


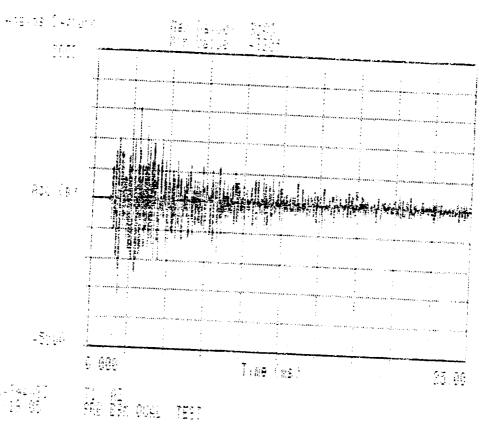


Appendix B Test Data

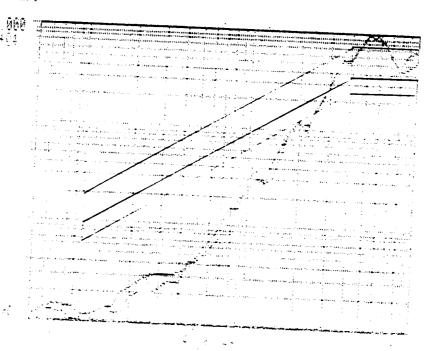


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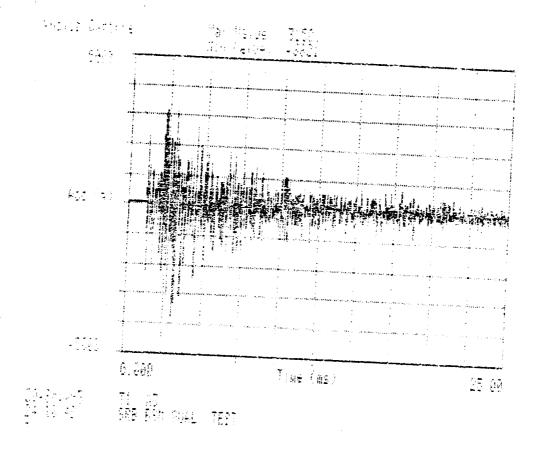




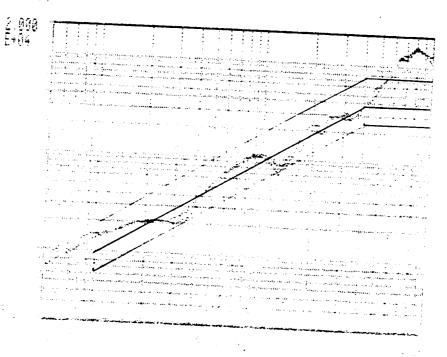
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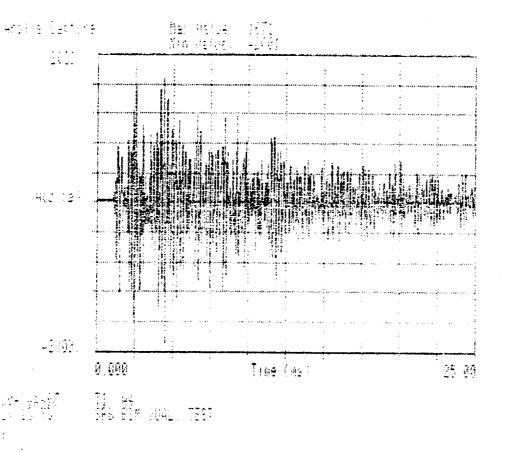
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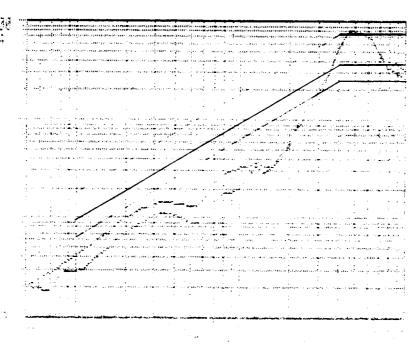
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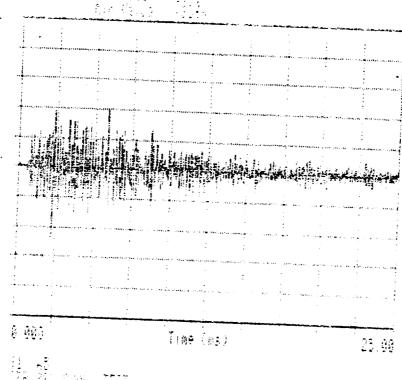


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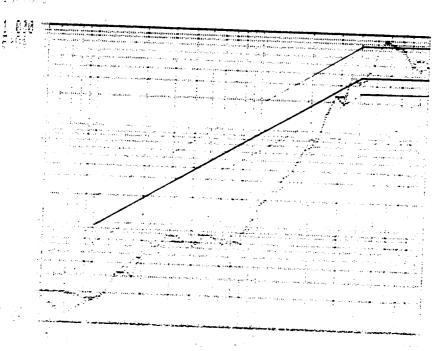
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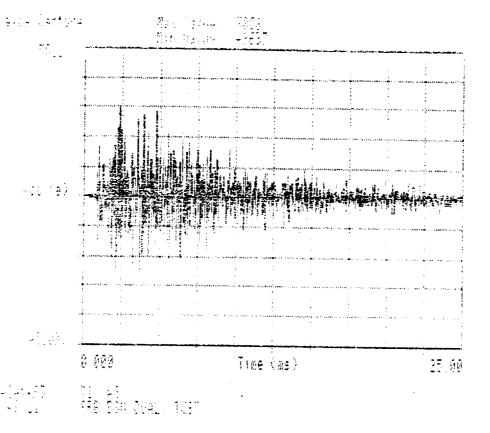
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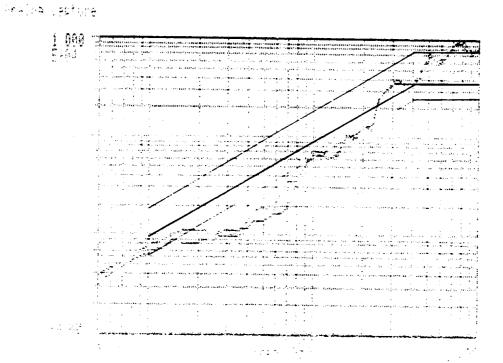


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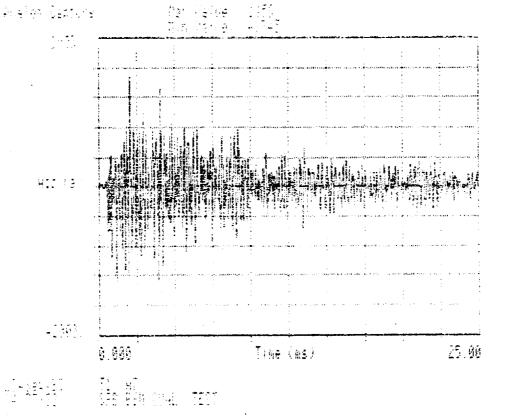
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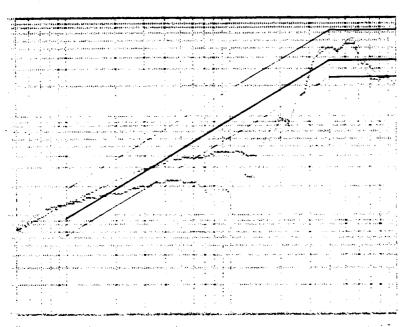




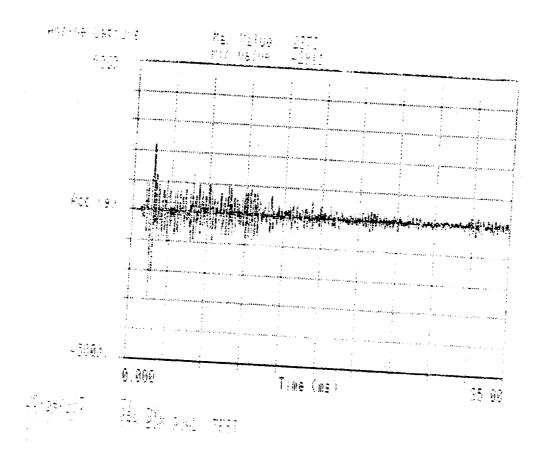
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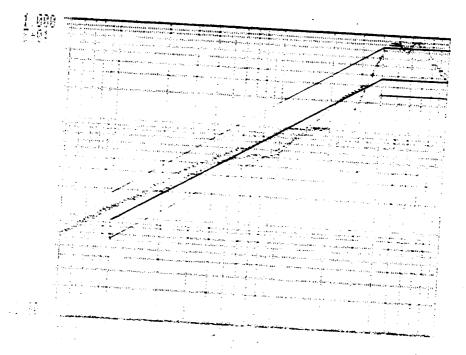
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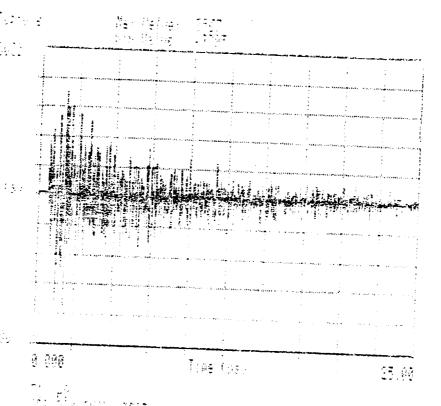


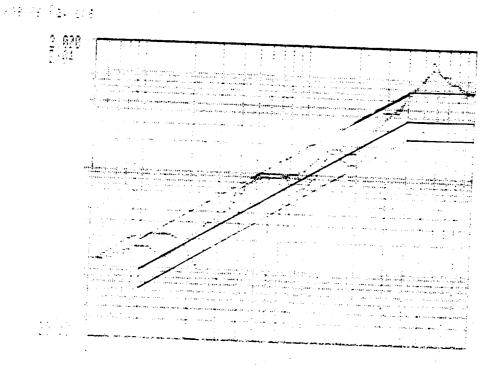
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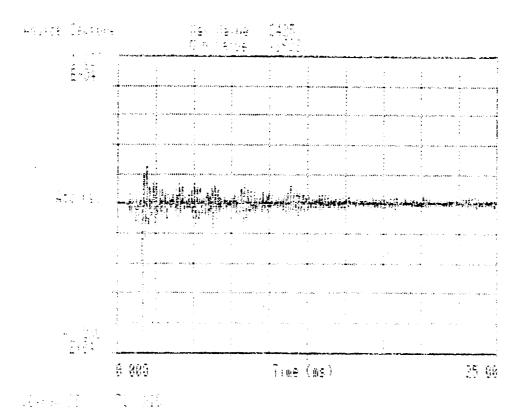


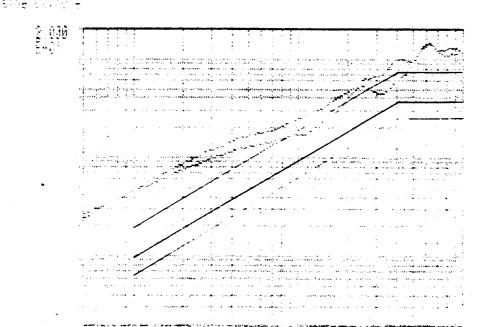
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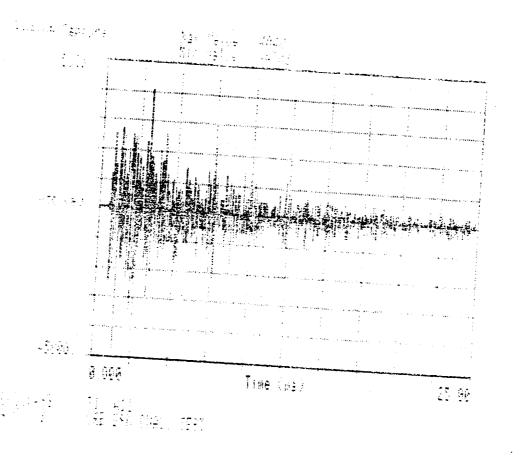




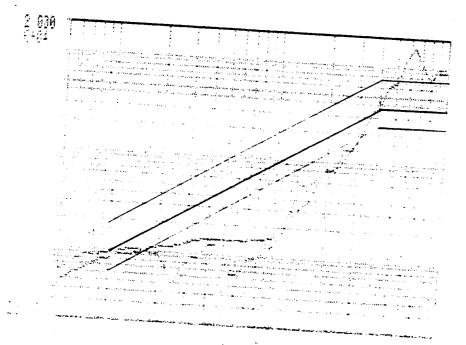


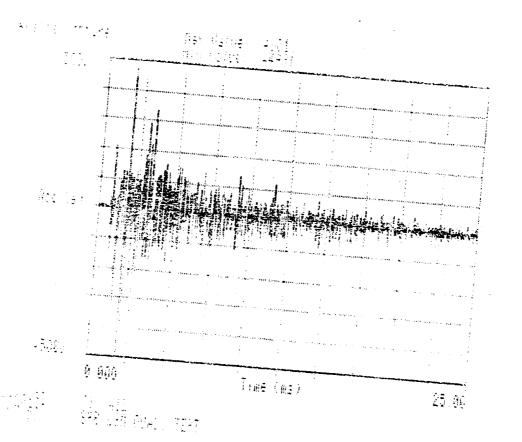


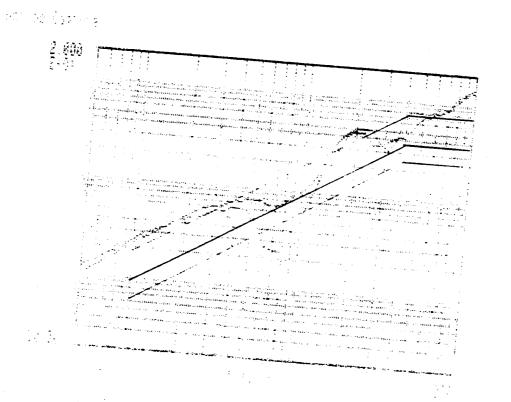


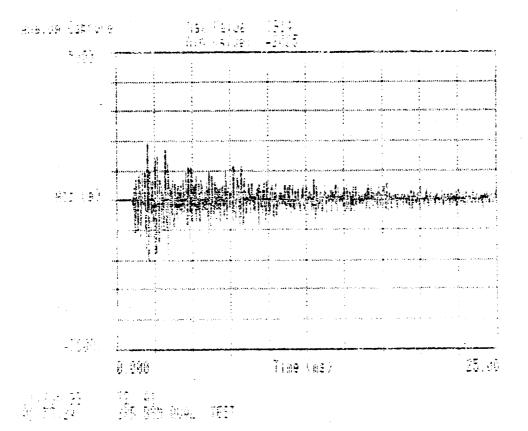


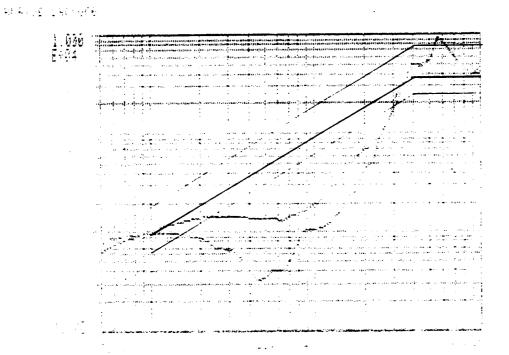


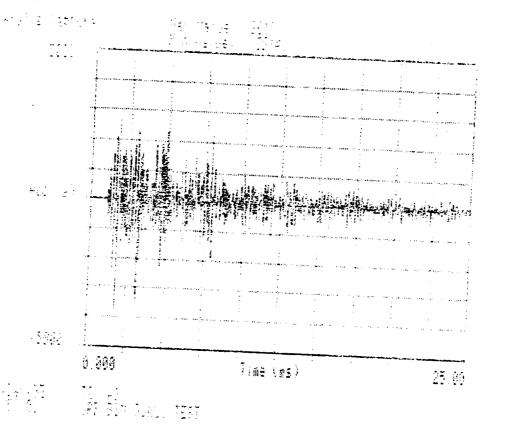


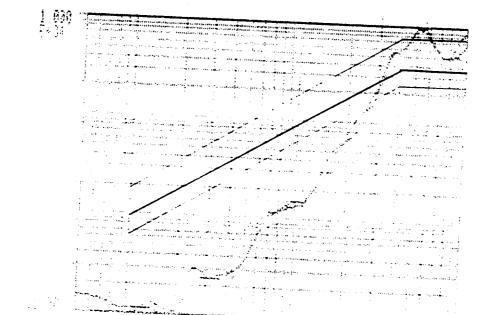




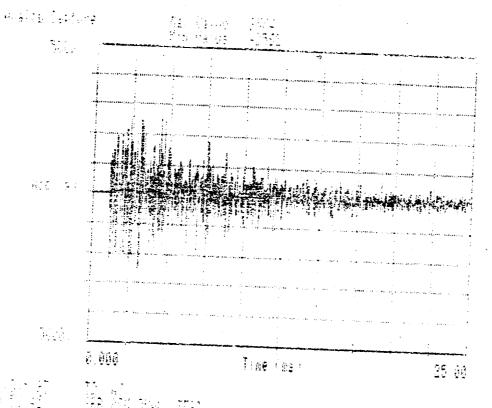


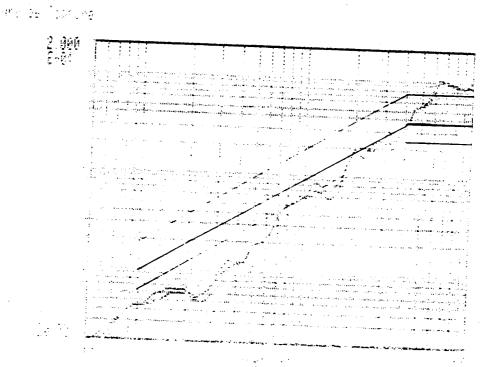






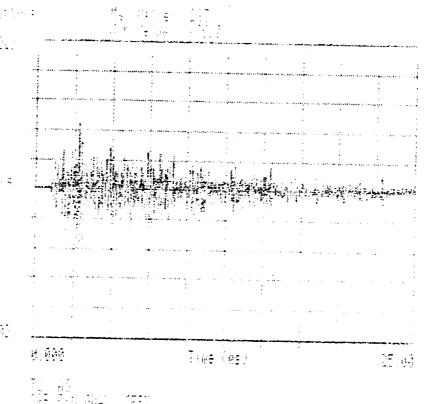
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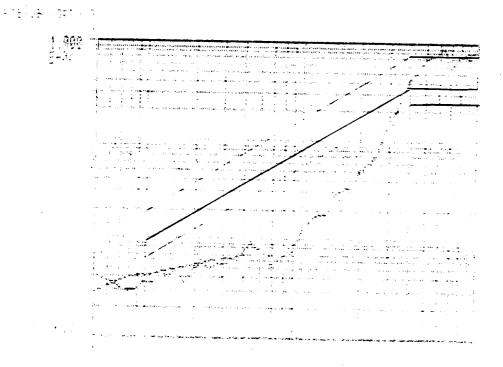


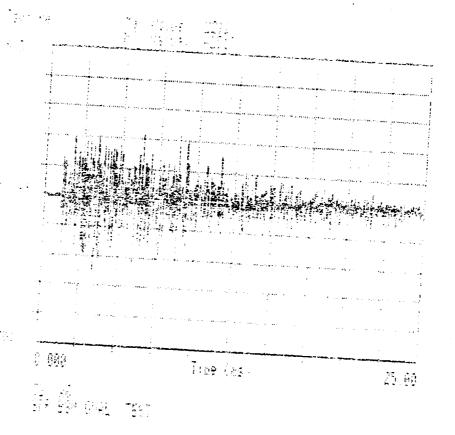


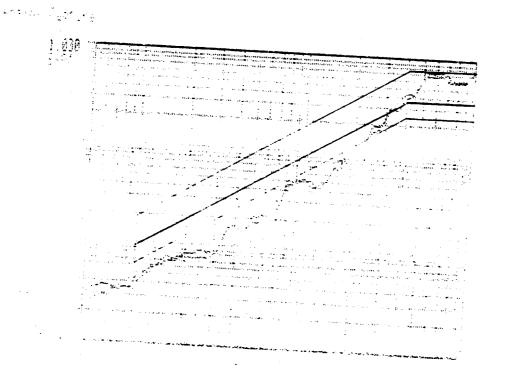
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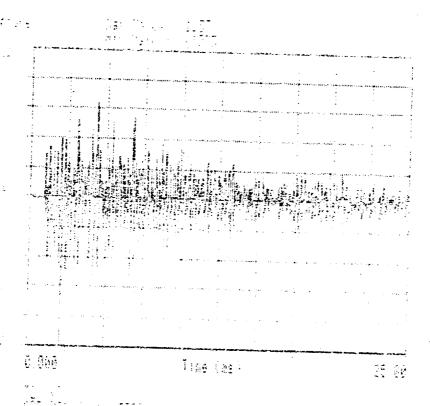
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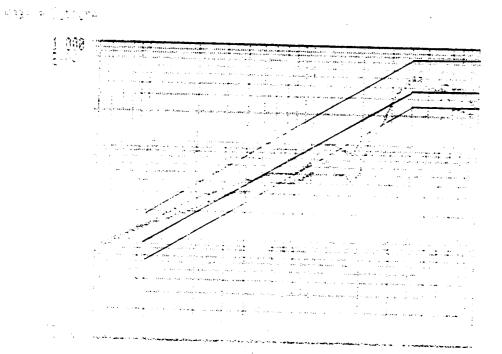


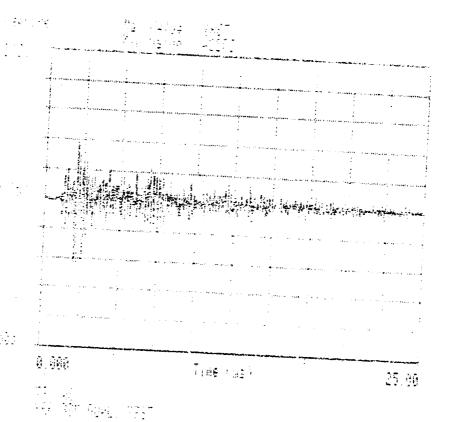


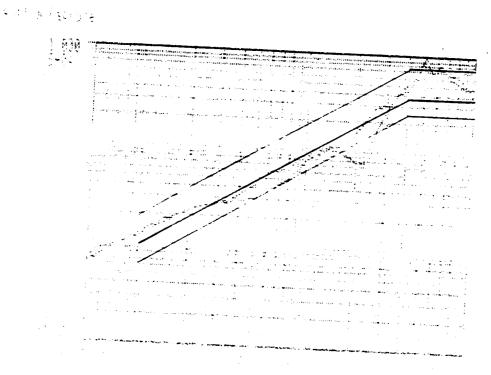


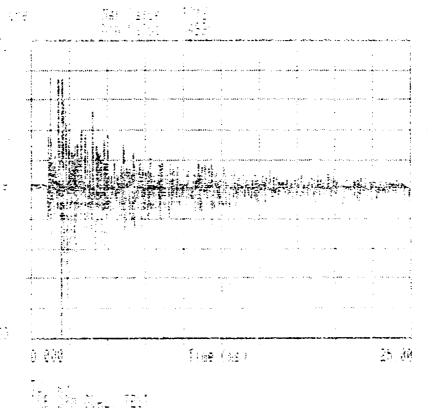


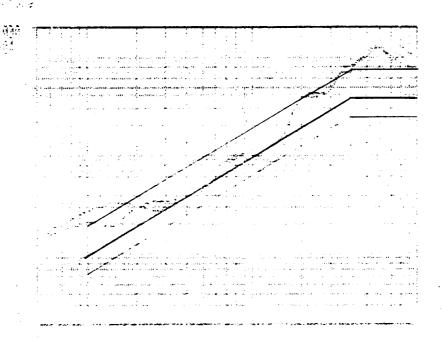


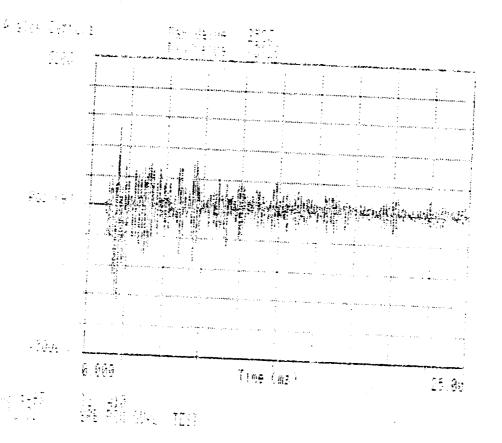




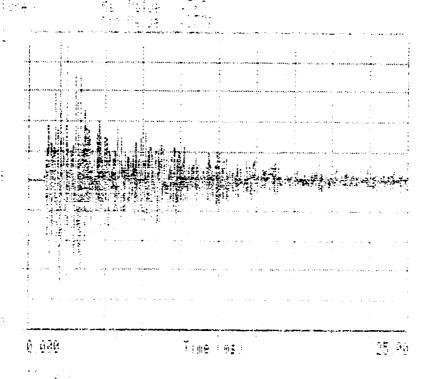


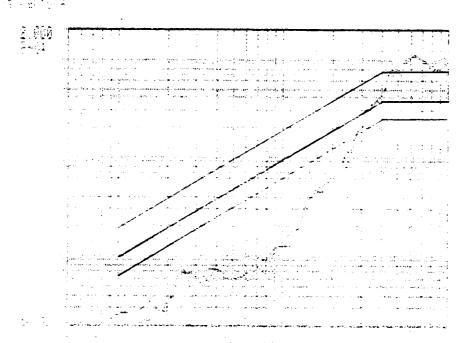


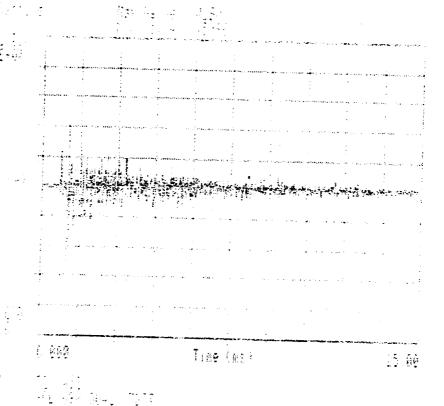


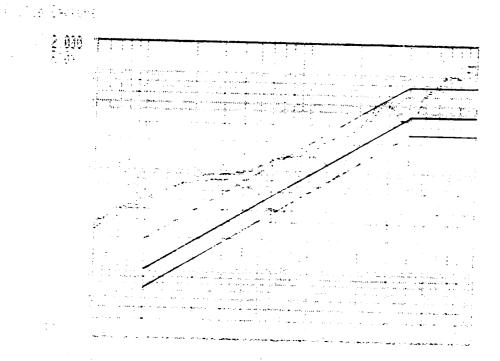


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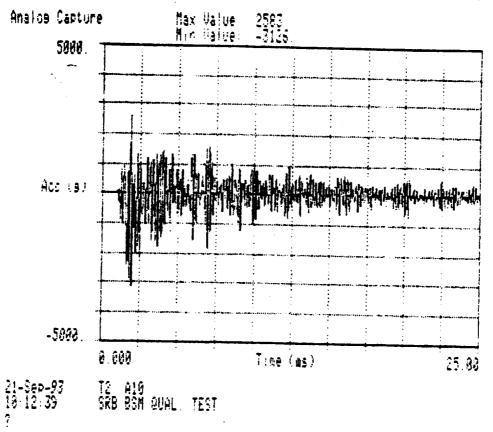


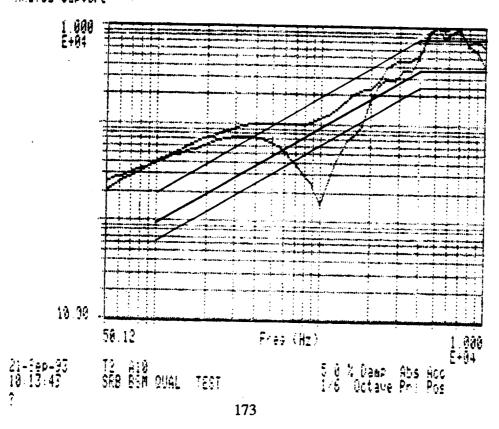


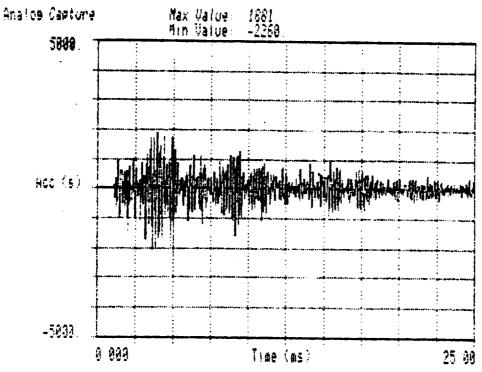


Appendix C Specification Exceedance Deviation

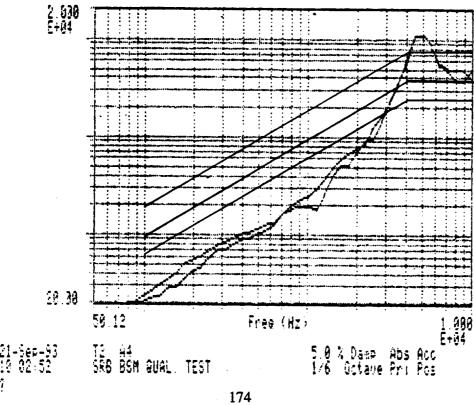
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				Y-axisi acceleromete Z-axis, acceleromete	er #11	9	
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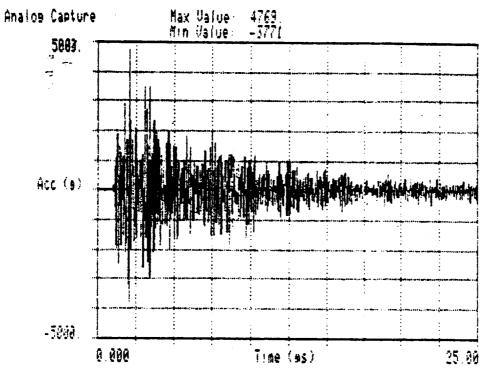




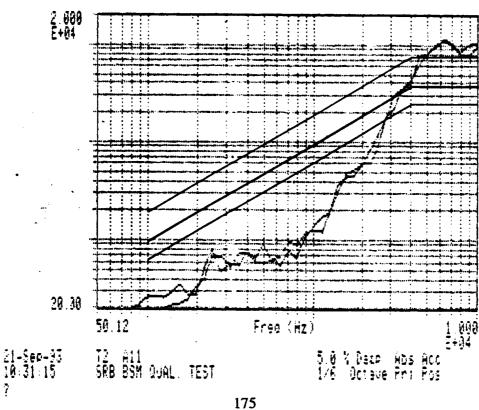


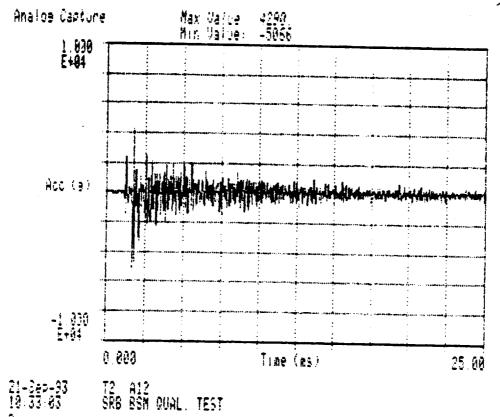
T2 A4 SRB BSM QUAL, TEST

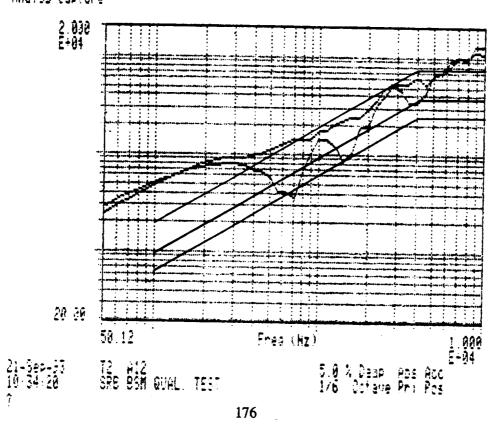


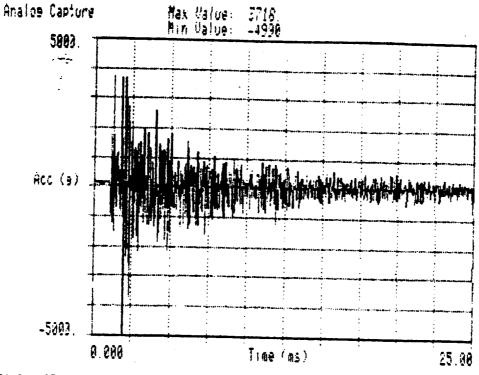


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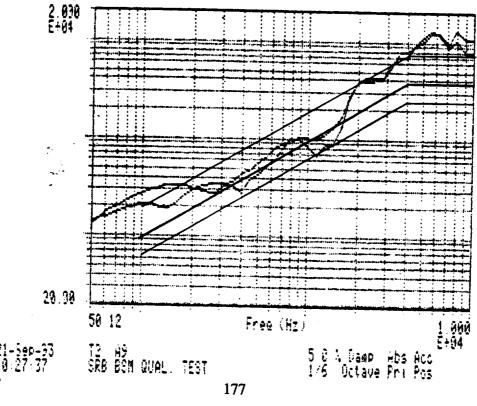








T2 A9 SRB BSM QUAL, TEST



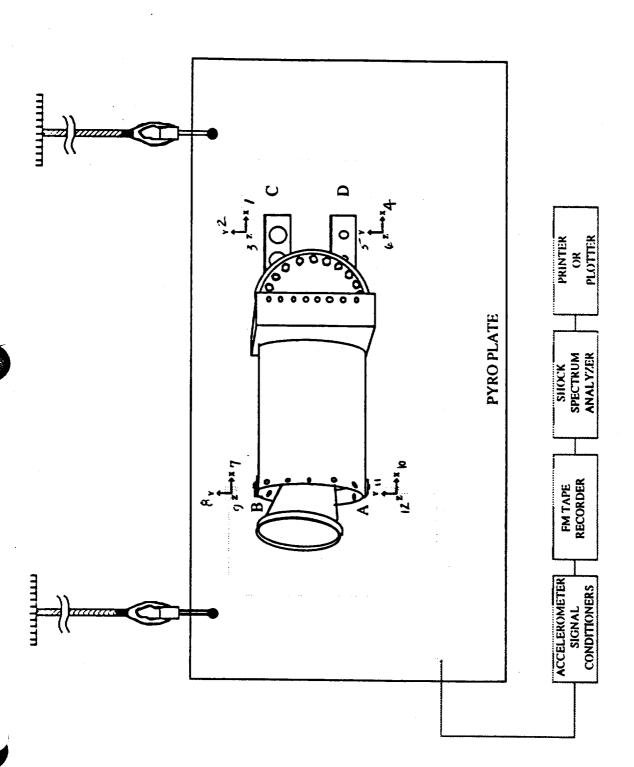
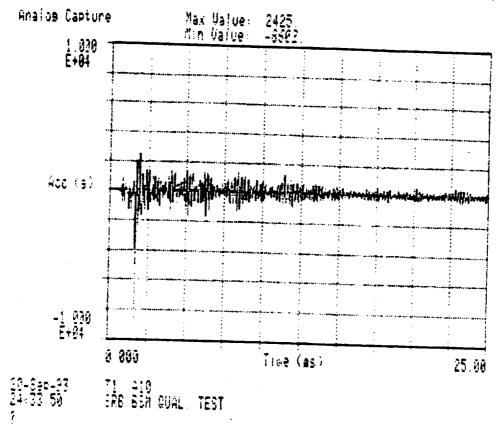
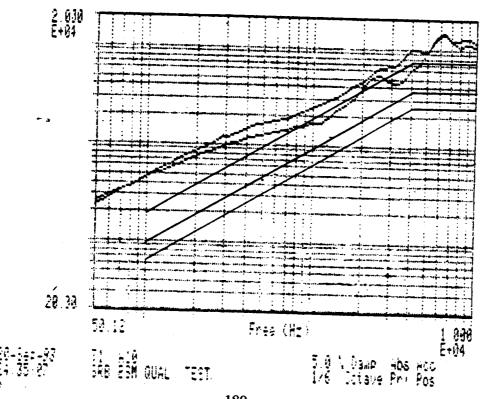
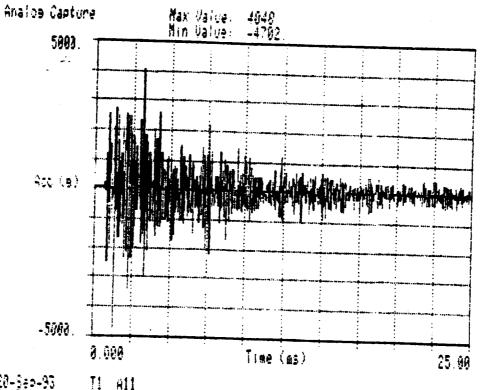


FIGURE 1. PYRO SHOCK CONTROL EQUIPTMENT

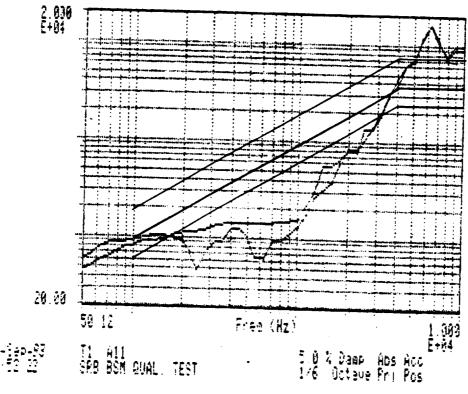
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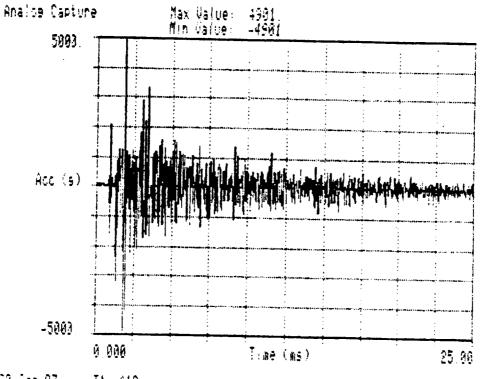






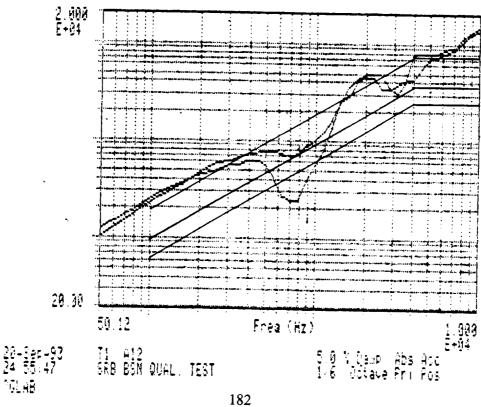
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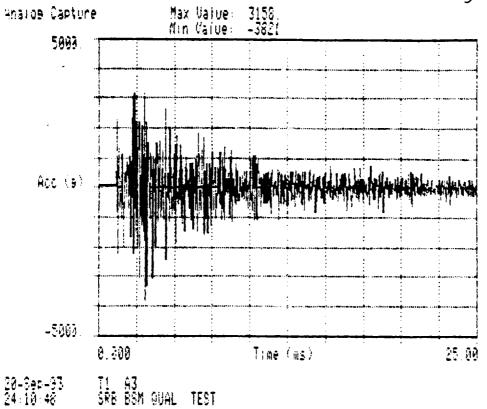


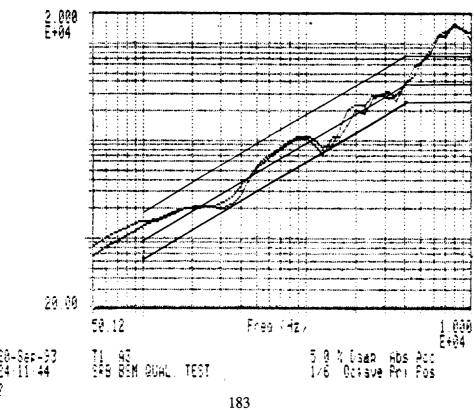


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Ans os Capture







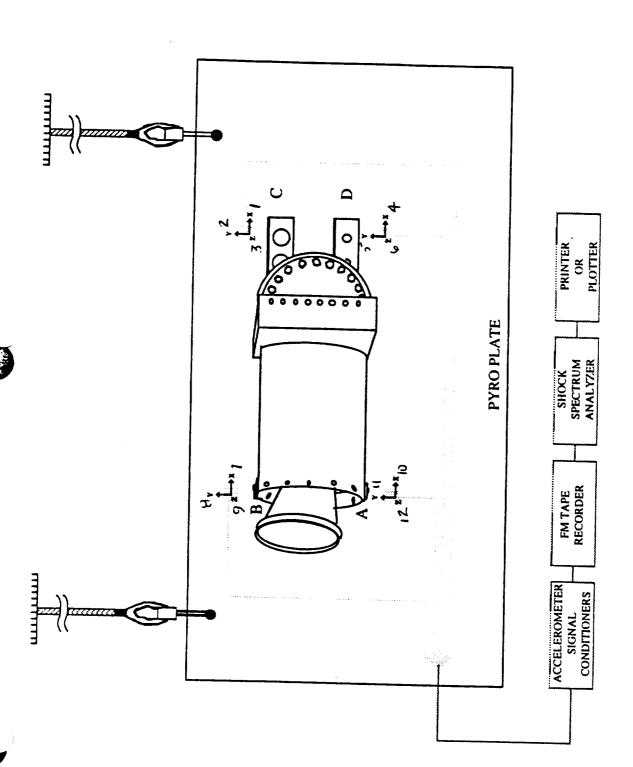


FIGURE 1. PYRO SHOCK CONTROL EQUIPTMENT

BSM MOTORS S/N 1000734 AND 1000738 VIBRATION TEST DATA

George C. Marshall Space Flight Center Marshall Space Flight Center, AL 35812



to Attn of: ED73 (93-101)

November 1, 1993

TO:

EE11/Mr. Smith

FROM:

ED73/Mr. Brewster

SUBJECT:

SRB Booster Separation Motor (BSM) Vibration

Qualification Test - SRB-QUAL-ED93-061

The Booster Separation vibration qualification tests were completed on two BSM motors SN 100034 and SN 100038 on September 20, 1993. Vehicle dynamics, random liftoff and random boost tests were performed on each motor in all three axes. The tests were run as specified in Document BSM-TCP-EP54-001, Title "BSM Delta Qualification Test," dated August 16, 1993.

Two control accelerometers and two axial response accelerometers were used for each test. The accelerometer locations and test axes are shown in figure 1. All instrumentation used for the test are shown in table 1.

This report contains all of the required data. Any questions concerning this report should be directed to Mr. J. McGee at 544-1136.

Steve R. Brewster

Chief, Dynamics Test Branch

teve R Brewst

Enclosure

cc:

ED23/Mr. Ferebee

ED73/Mr. Hofmann (4 copies)

EP54/Mr. Bevill (3 copies)

ED73/File Copy

USBI/Mr. Tieman

TEST AND CHECKOUT PROCEDURE FOR

VIBRATION QU	ALIFICATION TEST OF BOOSTER SEPA	RATION MOTOR (BSM)
SN 1006734	+ SN 1000738- SRB-QUAL-ED93	-061
Date of Test	: <u>9-20-93</u>	
Test Article	Serial Number: <u>SN 1000734 + 100</u>	0 738
Test Require	ments Documents: BSM-TCP-EP54	-001
FOP's Attach		
Type of Test	: VIBRATION QUALIFICATION	
PREPARED BY:	Test Engineer/ED73	<u>7-20-93</u> Date
	Engineering Technician/ED73	Date
APPROVED BY:	Steve R. Brewster/ED73 Chief, Dynamics Test Branch	11-1-93 Date
APPROVED BY:	Quality Assurance	7-20-93 Date

1.0 PURPOSE

This procedure defines the steps necessary to assure the proper check-out for and the execution of vibration and shock tests.

2.0 SCOPE

This procedure includes test levels, instrumentation and documentation necessary for the Test Engineer to conduct vibration and shock tests.

3.0 APPLICABLE DOCUMENTS

DST-FOP-VS-003 FACILITY OPERATION PROCEDURE (MARCH 21, 1983)

4.0 GENERAL REQUIREMENTS

The Test Engineer will be in charge of all preparations and activities during the vibration test phase.

5.0 SAFETY

When safety critical test conditions require personnel access, the Test Engineer will assure that the operation procedures and policies set forth in ET01-SOP-01, "Standard Operating Procedure for Safety Critical Operations" will be adhered to.

The Test Engineer will be responsible for the safety of personnel involved in the test activities; and will be notified immediately of any personnel injury.

TEST CONTROL PROGRAMS

1. IOENT: RSM, LIFT-GEF PADIAL

2. TPUE PANDOM MODE? YES,NO

3. AVERAGING WEIGHTING FACTOR?

AUGS/LOOP?

4. 3 SIGMA CLIPPING? YES, NO YES

S. MEASUREMENT MODE? YES,NO

\$ OF AUGS?

AUGS/LOOP?

6. \$ CONTROL CHANNELS?

EXTREMAL CONTROL? VES,NO

7. CALIBRATION? MUZ

CHANNEL B

CHANNEL C 100.00

8. SYSTEM GAIN? GZUOLT @ INPUT

9. SELF CHECK LEVEL? -DB

10. LEUEL SCHEDULE 1EUEL(-DB), TIME(SEC)7 1. -9.00 20. 2. -6.00 10. 3. -3.00 5. 4. .00 62.

11. LINE ABORTS ENABLED? -DB

ABORT TIME? 10 SEC MAX 1.00

12. MANUAL MODE ENABLED? VES, 110

13. LINE ALARM LIMIT? x 99.00

14. RMS ABORT LIMIT? DB 3.00

15. # LINES? 512

16. LOWEST FREG? 20.00

17. HIGHEST FREG? 2000.00

MAX FREG. = 2500.00 HZ

LOG HORIZ. 3 DECADES RESOLUTION. 4.88 HZ

18. INPUT MODE? 1-MAG, FREG, LIMIT+, LIMIT-(DB); 2-SLOPE, FREG, LIMIT+, LIMIT-(DB); 3-DISC

19. MAGNITUDE? GSOR/HZ, F. 20 HZ

20. NAG., FREO, LIMIT+, -7 .077000 55.00 3.00 1.50

21. NAG., FREQ.LIMIT+, -> .077000 200.00 3.00 1.50 22. MAG.,FREG.LIMIT+,-7 .022000 280.00 3.00 1.50

23. MAG.,FRE0,LIMIT+,-7 .022000 1200.00 3.00 1.50

24. MAG.,FRED,LIMIT+, -?

FUNCTION? /C,/R,/L,/S,DL,PU,/E,?? RMS VALUE - 6.944 G'S

I's INCHT:

TRUE RANDOM MODE? (ES) NO

3. AUERAGING WEIGHTING FACTORP

F 557 LOOF?

1. 3 SIGMA CLIPPING? YES,NO

3. NEASUREMENT MODE? YES, HO YES

OF AUGS?

4995/100P2

3. # CONTROL CHANNELS?

EXTREMAL CONTROL? YES, NO

2. CALIBRATION? MUS

CHAMMEL A

CHANNEL B

CHANNEL C

SYSTEM GAIN? G/UOLT @ INFUT 28.00

1. SFLF CHECK LEUEL? -DB

11. LINE ABLETS ENABLED? -DE

ABORT TIME? 10 SEC MAX

12. MANUAL MODE ENABLED? YES,NO

13. LINE ALARM LIMIT? 4

14. RMS ABORT LIMIT? DB 3.00

15. # LINES? 512

16. LOWEST FREG? 20.00

17. HIGHEST FREG? 2000.00

MAX FREG. - 2500.00 HZ

RESOLUTION. 4.88 HZ

LOG HORIZ. - 3 DECADES

18. INPUT MODE?
1.MG.,FREG,LIMIT+,LIMIT-(DR);
2.SLOPE,FREG,LIMIT+,LIMIT-(DR);
3.DISC

19. MAGNITUDE GSOR/HZ, F. 20 HT.

20. MAG., FREQ.LIMIT+, -2 .540000 200.00 3.00 1.50

21. MAG., FREG, LIMIT+, -2 .060000 350.00 3.00 1.50

23. NAG., FREG, LIMIT+, -?

PHS UALUE. 14.056 G/S

FUNCTION? /C,/R,/L,/S,DL, PU,/E,79

2. LOWER FREG LIMIT? HZ 5.0

1. IDENT?

10. NUMBER OF CONTROL CHANNELS?

ACCELERATION CALIBRATIONS? CHANNEL 8, MU/G 1 300.000 CHANNEL 8, MU/G 2 300.000

3. UPPER FREG LIMIT? HZ 40.0

4. STARTING FREG? (+UP, -DOWN)

S. NUMBER OF SINGLE SWEEPS?

6. SUEEP MODEP 1-LOG, 2-LIN

7. SUEEP TINE OR RATE? 1-TIME, 2-OCT/MIN, 3-DEC/MIN 5077MIN7 3.00 SUEEP TIME • 1.000 MIN

8. REFERENCE ENUELOPE SPECIFICATION UNITS? 1-IN, 2-CM

FORMAT: FREG, AMPL, TYPE, LIMIT(DB)

AMPLITUDE TYPES: 1-6'S P ,2-IN/SEC ,3-IN P-P

ENTER 0 TO TERMINATE

FOINT # 17 5.0 .7008 1 3.00 .70 G/S, 8.601 IN/S, .5475 IN) POINT # 27 9.5 7000 1 3.00 .70 G/S. 4.527 IN/S, .1517 IN) POINT # 37 10.0 3.7000 1 3.00 3.70 G'S, 22.730 IN/S, .7235 IN)

9. MUX? YES,NO

.0452 IN)

POINT # 4? 40.0 3.7000 1 3.00 3.70 G'S, 5.683 IN/5,

11. CONTROL NEAS METHOD? 1-PEAK, 2-AUG, 3-RMS,

12. CONTROL STRATEGY? 1-MAX, 2-MIN, 3-AUG

13. NUMBER OF LIMIT CHANNELS?

15. NUMBER OF MEAS CHANNELS? MEAS SPECIFICATIONS?
CHANNEL #, MUCUNIT
A 300.000
CHANNEL #, MUCUNIT
GLANNEL #, MUCUNIT
A 100.000
A 100.000 16. MEASUREMENT MEAS METHOD? 1-PEAK, 2-AUG, 3-RMS, 4-FILTER

18. SHUT-DOUN TIME? SEC 1.0 17. START-UP TIME? SEC 5.0

19. MANUAL NODE ENABLED? YES,NO YES

20. MAX DRIVE? NV PEAK Seed.

21. SELF CHECK LEUEL? NU PEAK 500 22.

ALARM LEUEL? * ABORT 99.0

3. TRUE RANDOM MODE? YESING I. IDENT:

3. AVERAGING WEIGHTING FACTOR?

AUGS/LOOP?

4. 3 SIGNA CLIPPING? VESINO

3. MEASUREMENT MODE? VESINO

OF AUGS? 20

AUGS/LOOP?

3. # CONTROL CHANNELS?

EXTREMAL CONTROL? YES, NO

?. CALIBRATION? NU/G

CHANNEL B CHANNEL C

1. SYSTEM GAIN? G/UOLT & INPUT

). SELF CHECK LEUEL? -DB

(0. LEUEL SCHEDULE LEUEL(-DB), TIME(SEC)? 1. -9.00 20. 2. -6.00 20. 3. -3.00 50. 4. .00 62.

1. LINE ABORTS ENABLED? -DB

12. MANUAL MODE ENABLED? YESINO ABORT TIME? 10 SEC MAX

13. LINE ALARM LIMITO X 99.00

14. RMS ABORT LINIT? DB

15. # LINES? 512

16. LOUEST FREG? 20.00

17. HIGHEST FREG? 2000.00

MAX FREG. - 2500.00 HZ

LOG HORIZ. • 3 DECADES RESOLUTION. 4.88 HZ

18. INPUT MODE? 1-MAG. FREG.LIMIT+,LIMIT-(DB); 2-SLOPE,FREG.LIMIT+,LIMIT-(DB); 3-DISC

19. MAGNITUDE? GSOR/HZ, F. 28 HZ

20. MAG.,FREG.LINIT+,-7 .860000 75.00 3.00 1.50

21. MAG. FREG, LIMIT+, -? . 668888 1888.88 3.88 1.58

22. MAG., FREQ, LINIT+, -? .030000 200.00 3.00 1.50

RMS UALUE" 9.969 G'S

FUNCTION? /C,/R,/L,/S,DL,PU,/E,??

YES HEASUREMENT MODE? VESINO ES OF AUGS? CONTROL CHANNELS?	14. RMS ABORT LIMI: 3.00 14. RMS ABORT LIMI: 3.00 15. LOWEST FREG? 10. HIGHEST FREG? 2000.00 MAX FRE >500.00 HZ RESULUTION 4.88
TIREMALLICHTROLY ALSINO ALIBRATATA BAG ANNEL A	18. INPU: 2 1-MAG, FREG, LIMIT+, LIMIT-(DP); 2-5LOPE, FREG, LIMIT+, LIMIT 3-D 1 1 :". MAG, GSOR/HZ,
PHUMBL C CHANNEL C 0.00 STEM GAIN? G INPUT	20. MAG. LIMI .vv. 800v. 800v. 800v. 800vvvvvvvvv.
1.F CHFFY FUEL? -DB 6.00 EUEL SCHEDULE 1.EUEL - FOR TIME (SEC.)? 26.00 33.00 400 125. 1.NE A: .00	FUNCTION? /C./R,/L,/S,DL,PU,/E,??

1. IDENT? BSM, U.D., TANG. 3. UPPER FREG LIMIT? HZ

B. LOUER FREG LIMIT? HZ

4. STARTING FREG? (+UP, -DOUN)

S. NUMBER OF SINGLE SWEEPS?

6. SUEEP MODE? 1.LOG, 2.LIN

7. SUEEP TIME OR RATE? 1-TIME, 2-OCT/MIN, 3-DEC/MIN 0CT/MIN? 3.00 SWEEP TIME - 1.000 MIN

8. REFERENCE ENVELOPE SPECIFICATION UNITS? 1-1N, 2-CM

FORMAT: FREO,AMPL,TYPE,LIMIT(DB)

AMPLITUDE TYPES: 1-6'S P ,2*IN/SEC ,3*IN P-P

ENTER 0 TO TERMINATE

POINT # 17 5.0 .7000 1 3.00 .70 G/S, 8.601 IN/S, .5475 IN)

POINT # 27 9.5 .70 G'S, 4.527 IN/S, .1517 IN) POINT # 37 10.0 4.3000 I 3.00 4.30 G'S, Z6.416 IN/S, .8409 IN)

POINT # 47 40.0 4.3000 1 3.00 4.30 G/S, -6.604 IN/S, .0526 IN)

9. MUX2 YES, NO

10. NUMBER OF CONTROL CHANNELS?
ACCELERATION CALIBRATIONS?
CHANNEL #, NU/G
1 300.000
CHANNEL #, NU/G
2 300.000

11. CONTROL MEAS METHOD? 1-PEAK, 2-AUG, 3-RMS, 4-FILTER

12. CONTROL STRATEGY?

13. NUMBER OF LIMIT CHANNELS?

MEAS SPECIFICATIONS?
CHANNEL #, MU/LINIT
1 300.000
CHANNEL #, MU/LINIT
2 300.000
CHANNEL #, MU/LINIT
3 100.000
CHANNEL #, MU/LINIT
4 100.000

16. MEASUREMENT MEAS METHOD? 1.PEAK, 2.AUG, 3.RMS, 4.FILTER

17. START-UP TIME? SEC 5.0
18. SHUT-DOWN TIME? SEC 1.0

19. MANUAL MODE ENABLED? YES,NO

20. NAX DRIVE? NV PEAK 5000. 21. SELF CHECK LEVEL? NV PEAK

22. ALARM LEUEL? * ABORT 99.0

MAX DISP . .8409 IN P-P MAX UEL . 26.416 IN/SEC P MAX ACCEL . 4.30 G'S P

SSM, LIFT-OFF LONG.

3. AVERAGING WEIGHTING FACTOR?

2. TPUE RANDOM MODE? VESTNO

AUGS/LOOP?

4. 3 SIGMA CLIPPING? VESINO

5. MEASURENENT MODE? YESINO YES

OF AUGS?

AUGS/LOOP?

5. # CONTROL CHANNELS?

EXTREMAL CONTROL? YES, NO

7. CALIBRATION? MU/G

CHANNEL A

CHANNEL B

CHANNEL C

3. SYSTEM GAIN? G/UOLT @ INPUT

3. SELF CHECK LEVEL? -DB -6.00

-6.8e

10. LEUEL SCHEDULE
LEUEL(-DB), TIME(SEC)?
1. -9.(' 20.
2. -6./d 10.
5. -6./d 10.
5. -6./d 62.

11. LINE APOFTS ENABLEDS -DB

12. MANUAL MODE ENABLED? YES,NO ABORT TIME? 10 SEC MAK

13. LINE ALARM LIMIT? %

14. RMS ABORT LIMIT? DB

15. # LINES? 512

16. LOUEST FREG?

17. HIGHEST FREG? 2000.00

MAX FREG. . 2500.00 HZ

LOG HORIZ. 3 DECADES RESOLUTION. 4.88 HZ

18. INPUT MODE? 1-MAG.,FREG,LIMIT+,LIMIT-(1 2-SLOPE,FREG,LIMIT+,LIMIT-(1 3-DISC

19. MAGNITUDE? GSQR/HZ, F. 20 HZ .016000

20. MAG., FREG, LIMIT+, -2 . 060000 75.00 3.00 1.50

21. NAG., FREG, LIMIT+, -2 .060000 1000.00 3.00 1.50

22. MAG., FREG, LIMIT+, -, .030000 2000.00 3.00 1.50

9.969 6'5 RMS VALUE.

FUNCTION? /C,/R,/L,/S,DL,PU,/E,??

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1. IPENT: BSM. BAGST LONG.

2. TPUE RANDOM MODE? YES, NO YES

3. AUERAGING WEIGHTING FACTOR?

4. 3 SIGMA CLIPPING? YES, NO YES AUGS/LOOP?

S. MEASUREMENT MODE? YES,NO YES

OF AUGS?

AUGS/LOOP?

6. \$ CONTROL CHANNELS?

EXTREMAL CONTROL? VESINO NO

7. CALIBRATI N? MUZG

CHANNEL A

CHANNEL B

CHANNEL C 30.00

8. SYSTEM GAIN? GAUOLT @ INPUT 37.00

9. SELF CHECK LEVEL? -DB -6.00

10. LEVEL SCHEDULE LEVEL(-DB), TIME(SEC)? 1. -9.00, TIME(SEC)? 2. -6.00 10. 3. -3.00 10.

11. LINE ABORTS ENABLED? -DB -3.00

ABORT TIME? 10 SEC MAX

12. MANUAL MODE ENABLED? YES;HO 13. LINE ALARM LIMIT? %

14. RMS ABORT LIMIT? DB 3.00

15. # LINES? 512

16. LOWEST FREG? 20.00

17. HIGHEST FREOP 2000.00

MAX FREG. - 2500.00 HZ

RESOLUTION. 4.88 HZ

LOG HORIZ. . 3 DECADES

18. INPUT MODE? 1-MAG., FREG, LIMIT+, LIMIT-(DB); 2-SLOPE, FREG, LIMIT+, LIMIT-(DB); 3-DISC

19. MAGNITUDE? GSOR/HZ, F. 20 HZ

20. MAG.,FREG,LIMIT+,-7 .240000 800.00 3.00 1.50

FUNCTION? /C,/R,/L,/S,DL,PU,/E,?? RMS UALUE. 18.442 6'S

SSM U.D. LONG.

3. UPPER FREG LIMIT? HZ

4. STARTING FREG? (+UP, -DOLN)

7. SWEEP TIME OR RATE? 1-TIME, 2-OCT/MIN, 3-DEC/MIN

8. REFERENCE ENVELOPE SPECIFICATION

UNITS? 1-IN, 2-CM

AMPLITUDE TYPES: 1-6'S P ,2-IN/SEC ,3-IN P-P

POINT # 37 10.0 4.3000 1 3.00 4.30 G'S, 26.416 IN/S, .8409 IN)

POINT # 47 40.0 4.3000 1 3.00 4.30 G'S, 6.604 IN'S, .0526 IN)

ACCELERATION CALIBRATIONS? CHANNEL #, MU/G 1 300.000 CHANNEL #, MU/G 2 300.000 :0. NUMBER OF CONTROL CHANNELS?

11. CONTROL MEAS METHODO 1.PEAK, 2.AUG, 3.RMS, 4.FILTER

12. CONTROL STRATEGY? 1-MAX, 2-NIN, 3-AUG

13. NUMBER OF LIMIT CHANNELS?

15. NUMBER OF MEAS CHANNELS? NEAS SPECIFICATIONS?
CHANNEL #, NU/UNIT
1 300.000
CHANNEL #, NU/UNIT
2 300.000
CHANNEL #, NU/UNIT
3 100.000
CHANNEL #, NU/UNIT

16. MEASUREMENT MEAS METHOD? 1-PEAK, 2-AUG, 3-RMS, 4-FILTER

17. START-UP TIME? SEC 5.0

18. SHUT-DOUN TIME? SEC 1.0

19. MANUAL MODE ENABLED? YES,NO YES

21. SELF CHECK LEVEL? MU PEAK 500 28. NAX DRIVE? NV PEAK S000.

22. ALARM LEUEL? * ABORT 99.0

A. LOWER FREG LIMIT? HZ

5. NUMBER OF SINGLE SWEEPS?

6. SUEEP MODEP 1-LOG, 2-LIN

SUEEP TIME - 1.000 MIN

FORMAT: FREG,AMPL,TYPE,LIMIT(DB)

ENTER 8 TO TERMINATE

POINT # 17 5.0 .7000 1 3.00 .70 G'S, 8.601 IN/S, .5475 IN)

Point # 27 9.5 .700@ 1 3.00 .70 G'S, 4.527 IN/S, .1517 IN)

9. MUX? YESINO

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POST-TEST VERIFICATION

: Test and Checkout Procedure <u>5RB-QUAL-ED93-06</u>; been satisfactorily completed and documented.

Submitted by:

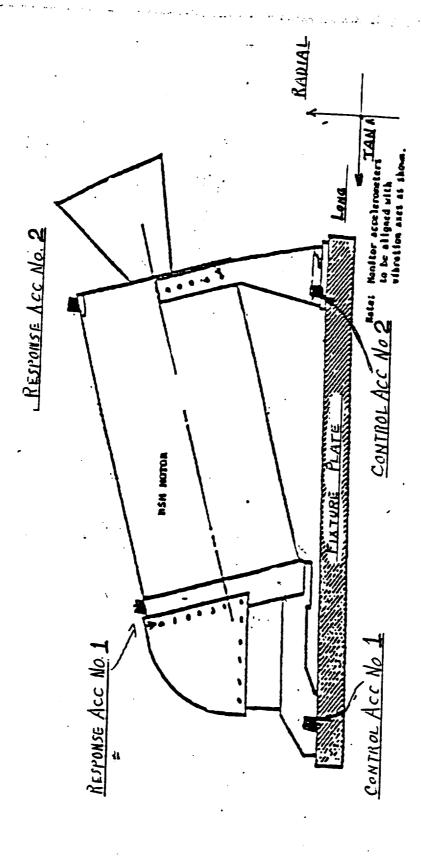
7. Cfel Test Engineer/ED73 <u>-20-9</u> Date

Verified by:

Quality Assurance

Date

Monitor



- * Control System H.P. Model 5427A S/N 1848A00160
- * Charge Amp Endevco Model 2775A S/N 783844 784074 784070 783846 783850
- * Power Amplifier Ling Model PSE 335 S/N 108
- * Shaker Ling B 335 S/N 628191
- * Voltmeter Keithley 193A S/N 303426
- * Counter HP 5316A S/N 2120A01228
- * Tape Recorder Datatape 37000 S/N 533772
- * Shaker UD T4000 S/N 353906
- * Power Amplifier UD T360 S/N 731628
- * Accelerometers Endevco 2227 S/N CF31 Endevco 2227 S/N PA73 Endevco 2226 S/N HA89 Endevco 2226 S/N AB37

Table 1

SN 100034 CHECK OFF LIST

DIV 1000100

TEST OPERATIONS SET-UP AXIS AXIS AXIS AXIS AXIS AXIS AND A L LONGITUDINAL AXIS A

Torque Values:

Test Fixture: 65 ft lbs

Test Article: Pen BSM TEST PLAN

Shaker Used: UD T-4000

Adapters: Used: MRAD 48 EXPANDER - 2 PLATE (90110063-1)

				-1 -	•
Perform levels as d		sud wer	rry wram	, give.	
Record the followin		c - 01	•		
Amplifier Ga	<u> </u>	6070	-		
Charge Amp.	F.S	305	_		
			٠	·	
	20 == e				
55_ ==					
== - <u>2</u>	000 == e	.010	<i>(</i>)	linits _	"1
Ez	E= e			limits _	· · · · · · · · · · · · · · · · · · ·
	Ez @			linits .	
==	E2 &			limits .	
	E= 0			linits	
_				limits	
 	= <u>6.9</u> G==				
_	= . <u>60</u> se				
.					

BOOST RANDOM SN 1000734

	RANDOM CHECK-CUT	
	AXIS RAD	14
	Verify test program and record RMS abort limit below.	٠.,
	RMS abort limit	V
	Perform levels as defined below and verify with plot.	/
	Record the following:	_
	Amplifier Gain75 %	
-	Charge Amp. F.S. 100 G	
•		
	20 = G ² /E:, linits <u>3/.5</u>	
	20 Ez - 200 Ez 2 51	15
	20 Ez - 200 Ez ê .54 " linits "	
	350 Ez - 1000 Ez a .06 " linits "	
	== - 2000 == e .015 linits !'	
	Ez Ez @ linits	
	iinits	
	Composite = 14 Gras	
	Test Time = 120 sec.	
	Test Level Concurrence:	
	Component Assessment Branch Date	

SN 1000734

1.1	Verify test program and r	ecord the abort :	AXIS	
	Abort Level	•		
1.2	Perform levels as defined	•		_/
1.3	Record the following:			•
	Amplifier Gain	4070		
	Charge Amp. F.S.	106	•	
-				· · · · · · · · · · · · · · · · · · ·
	5 - 10	Hz at .076	_,limit	_ dB
	10 - 40	Hz at 3.7 G	_,limit <u>+1.5</u>	dB
		Hz at	_,limit	dB
		Hz at		dB .
		Hz at		_ dB
	Sweep Rate = 3	oct/min		

page____of

LIFT OFF RANDOM SN 1000734

RMS abort limit		• •		
Perform levels as defined	below and	verify with	: plot.	
Record the following:		•		
· Amplifier Gain	70	70		
Charge Amp. F.S.	30	6	•	
				_
	e a .016	G ² /E=,	linits #	<u>:3,-1.5</u>
75 == - 1000 ==	z a <u>.060</u>	<u>'</u> '	limits _	- 11
== - <u>2000</u> ==	z 2 <u>.030</u>) 11	linits _	
== == == == == == == == == == == =			linits _	
Ez E	= e		lizits _	
	z e		limits _	
E2E	2 8		libits _	
E2 B			limits _	
	Ez 8	• ···•	<u>limits</u>	·
Composite = 10	GEES			
Test Time =		,		

BOOST RANDOM SN 1000734

RMS abort limit		ć3		<u></u>
erform levels as defined	below and ve	To		• •
ecord the following:				
Amplifier Gain	80.70	•		
Charge Amp. F.S.				
				
		G ² /E:,	limits 4	3-1
20 Hz - 800 Hz	.24	/1	iinits	11
== - <u>2000</u> =z	.017		 	10
E2 E2 (linits	
E2 E2			linits	
			limits	
Ez Ez (libits	
			limits _	
			limits	
Composite = 18.4	GIES			
Test Time = 120	_Sec.			

SN 1000 734

	Verify test program and record the	db	
1.2	Perform levels as defined below as	nd verify with plot.	
1.3	Record the following:		
<u>.</u>	Amplifier Gain 40	70	
	Charge Amp. F.S. 10 6		
•		4.3, limit	
	Hz at	,limit	dB
. •		,limit	 .
	Hz at	,limit	dB
	Sweep Rate = 3 oct/min Test level concurrence:		

LIFTOFF RANDOM SN 1000734

Verify tast program :	÷ <u>←</u>	/ d3	3	
Perform levels as de	fined belo	w and verify	r with plot.	
Record the following	•			
Amplifier Gai	<u>.</u>	70%		
Charge Amp.	f.s	306		•
•				
	20 == a	.016_ c	² /E:, limits	+3,-1.5
75 ==10	00 Ez ê	.06	linits	
	00 Ez 2	.03	limits	
==			المنات	
E2			limit	
=======================================			<u> </u>	s
	<u> </u>		<u>1:-1</u> t	s
			limit	5
			limit	.s
Composite	= 10	GIZS		
Test Time			•	

BOOST RANDOM SN 1000734

	RANDOM CHECK-CUT	, ,
		AIISLONGITVPINAL
1	Verify test program and record RMS abort limit	below.
	RMS abort limit d3	
2	Perform levels as defined below and verify wit	i pict.
3	Record the following:	
	Amplifier Gain 85	
•	Charge Amp. F.S. 100	
	== e G ² /E:,	linits +3,-1.5 db
		linits
	7.4.6	linits "
	* •	linits
		linits
		linits
*,	=======================================	linits
		linits
	Ez Ez &	limits
	Composite = 18.4 Gras	
	Test Time =	
	Mach Tarral on	
	Test Level Concurrence: Component Assessment B	Tanch Date

SN 1000734

1.1	Verify test program and	record the abor	AXI	
	Abort Level			·
1.2	Perform levels as defin			and selection of the
1.3	Record the following:			
	Amplifier Gain	4070		•
• 1	Charge Amp. F.S.	106		
• •				
	5 - 10	Hz at	,limit <u></u>	_ dB
• .			,limit'/	
		Hz at	,limit	_ dB
•		Hz at	,limit	_ dB
	-	_ Hz at	,limit	_ dB
	Sweep Rate = 3 Test level concurrence:	oct/min		

page___of

SN 1000734

Record a minimum of 30 seconds of calibration signal on tape recorder. Set full scale ranges on instrumentation amplifiers and note on data sheet. Set power amplifier gain to position noted during random test check-out. 110 Perform self check of control system. Begin test sequence at - 9 dB from full level. At - 6 dB, start tape recorder. Note time when full level is reached. SEE TAPE LOG At the completion of the test, set power amplifier gain to off. Stop tape recorder. Inspect test article for damage or degradation.

111

Remove test article from shaker.

11

SN 1000 734

RANDOM TEST BOOST	RADIAL T <u>ANGEN</u> IAL LONGITUDINAL
Record a minimum of 30 seconds of calibration signal on	
tape recorder.	vrv
Set full scale ranges on instrumentation amplifiers and	
note on data sheet.	201
Set power amplifier gain to position noted during random	
test check-out.	11-
Perform self check of control system.	100
Begin test sequence at $-\underline{9}$ dB from full level.	• / /
At - 6 dB, start tape recorder.	VVV
Note time when full level is reached. 5 Et TAPE LOG	111
At the completion of the test, set power amplifier gain	
to off.	VVV
Stop tape recorder.	VIV
Inspect test article for damage or degradation.	V * V
Remove test article from shaker.	VVV

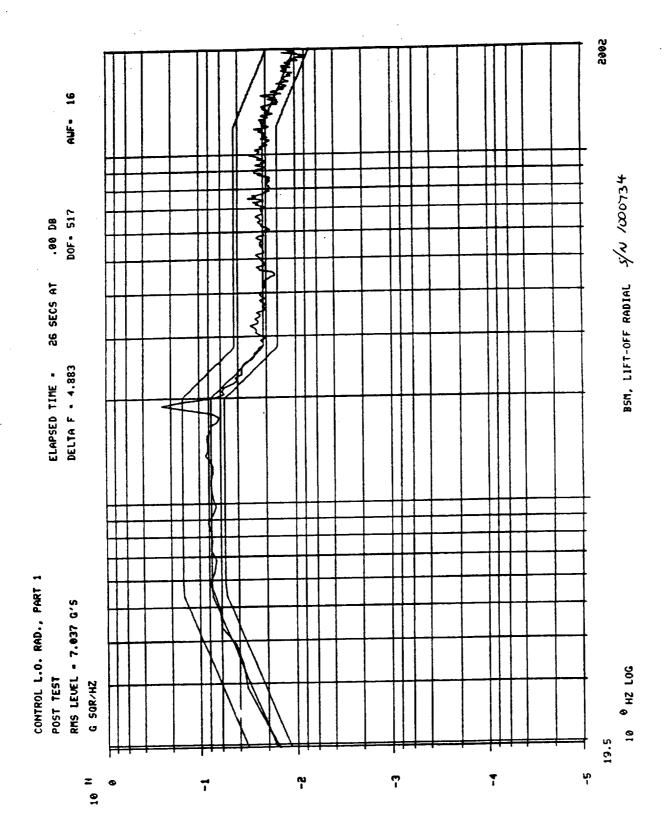
SN 1000734

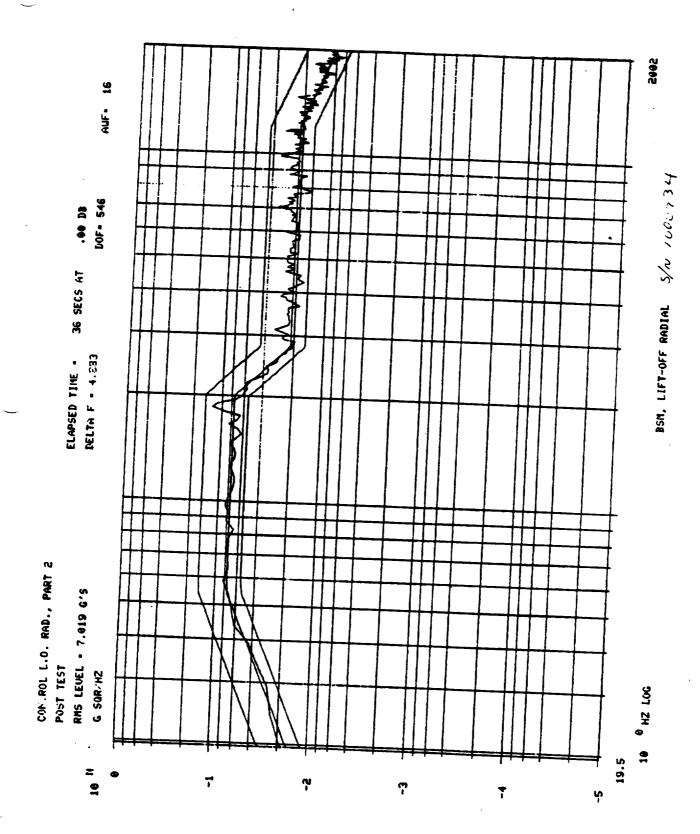
CL	E DYNAMICS TEST	AXIS RADIAL
1.	1 Record a minimum of 30 seconds of calibration signa	TANGENTIAL 1 on LONGITUDINAL
	tape recorder.	VVV
1.	2 Set full scale ranges on instrumentation amplifiers	and
	note on data sheet.	118
1.	3 Set power amplifier gain to position noted during s	ine
	test check-out.	4.00
1.	4 Perform self check of control system.	110
1.	5 Start tape recorder.	111
1.	6 Begin sine sweep	110
1.	7 Note time of DCS "SWEEP UP" or "SWEEP DOWN" indicati	
	light. JEE TAPE LOG	V 1"
1.	8 During first sweep, press the "SAVE" button on DCS.	V 10
1.		
	"SWEEP DOWN" indication light.	
1.		
,	gain to off.	
1.	11 Stop tape recorder.	
1.		<u> </u>
		* * * *

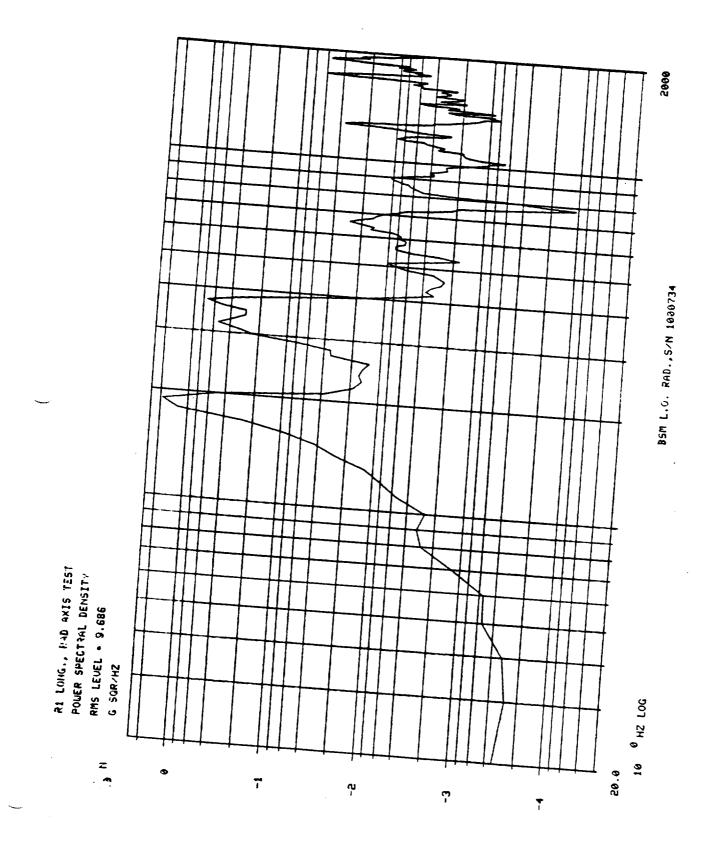
page _____of ____

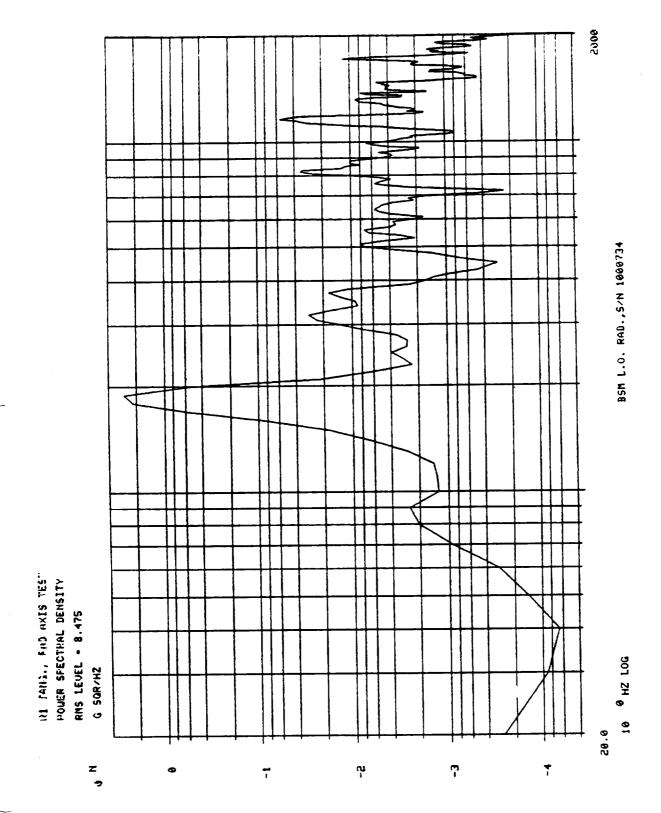
SN 100034 TEST DATA TEST DATA S/N 1000734

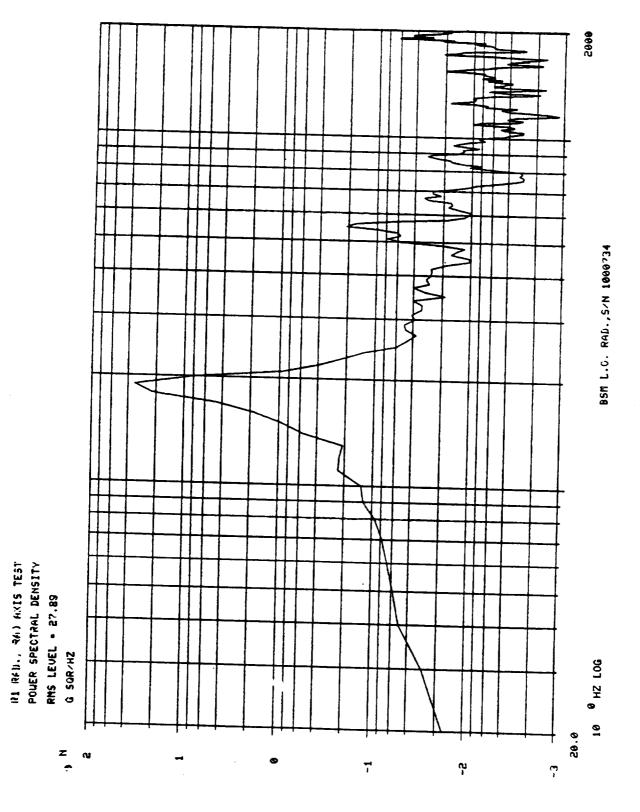
RANDOM, LIFT-OFF, RADIAL AXIS

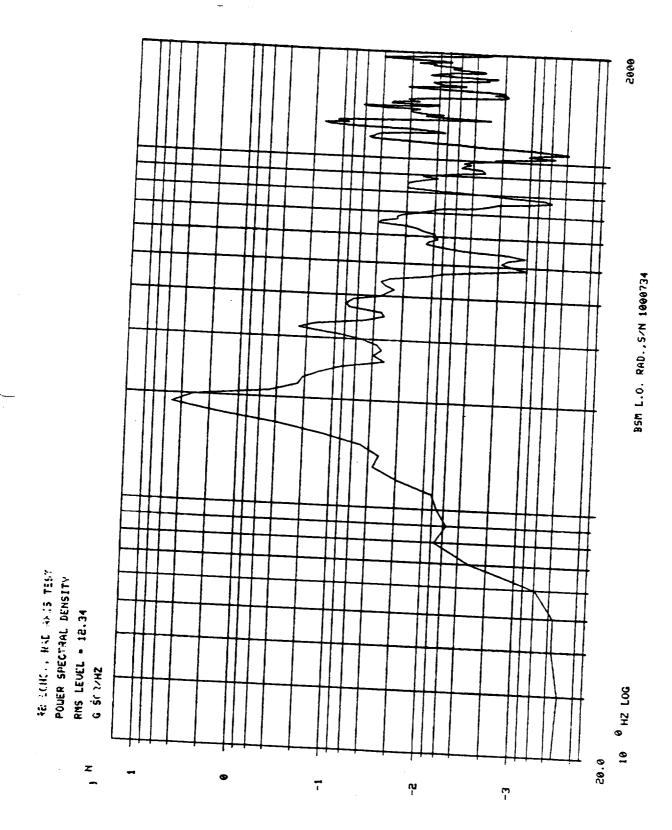


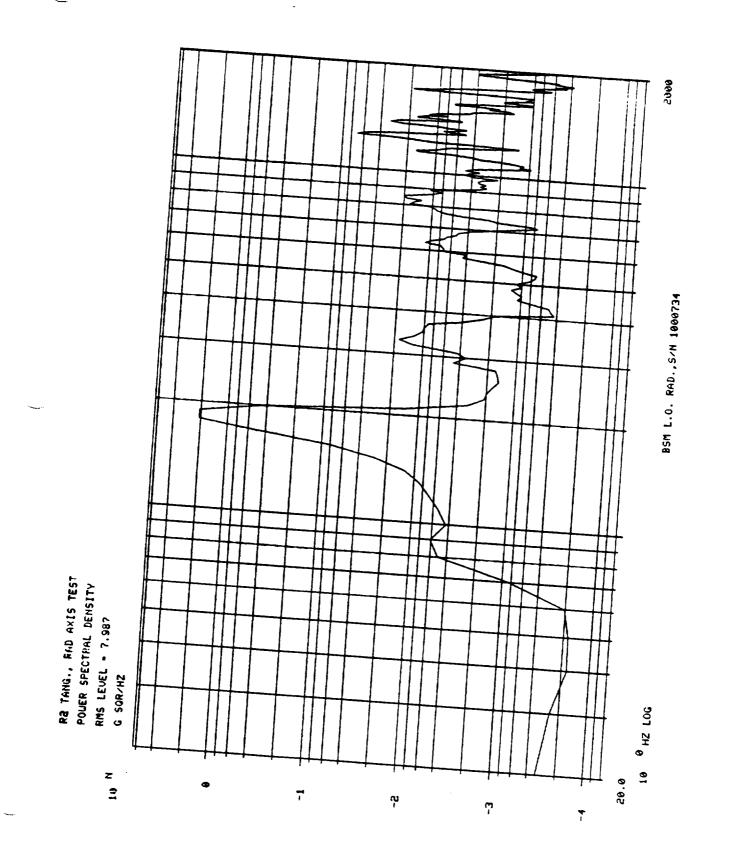


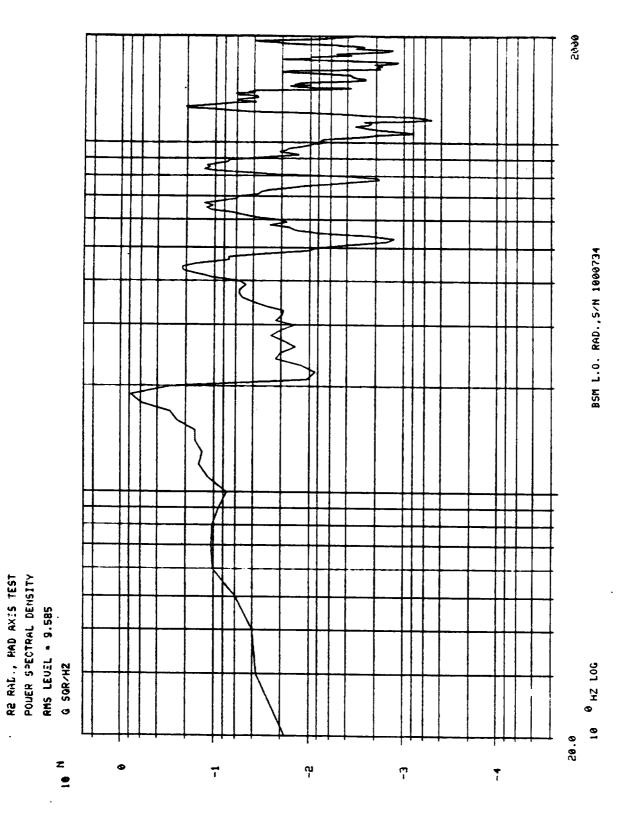




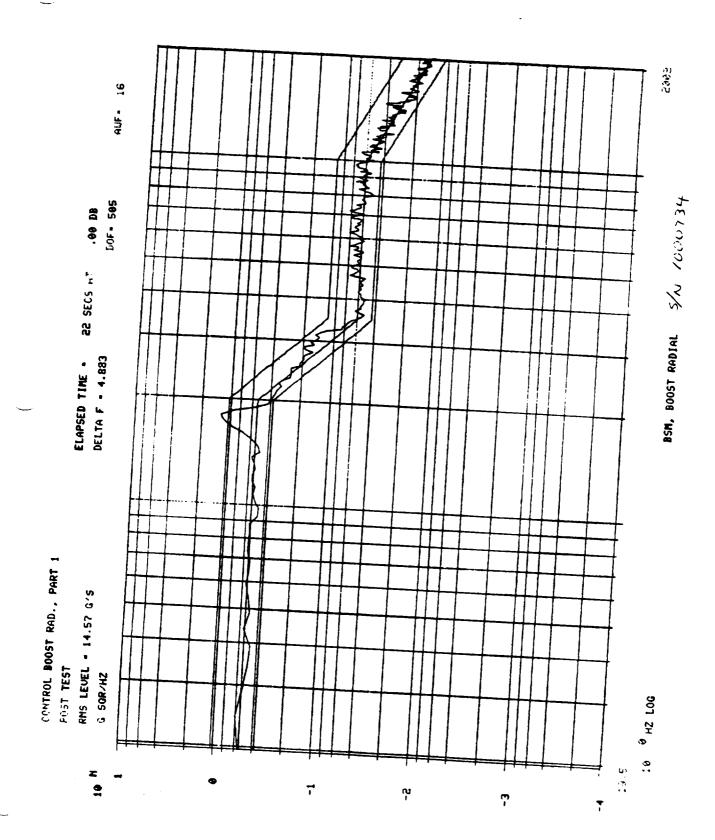


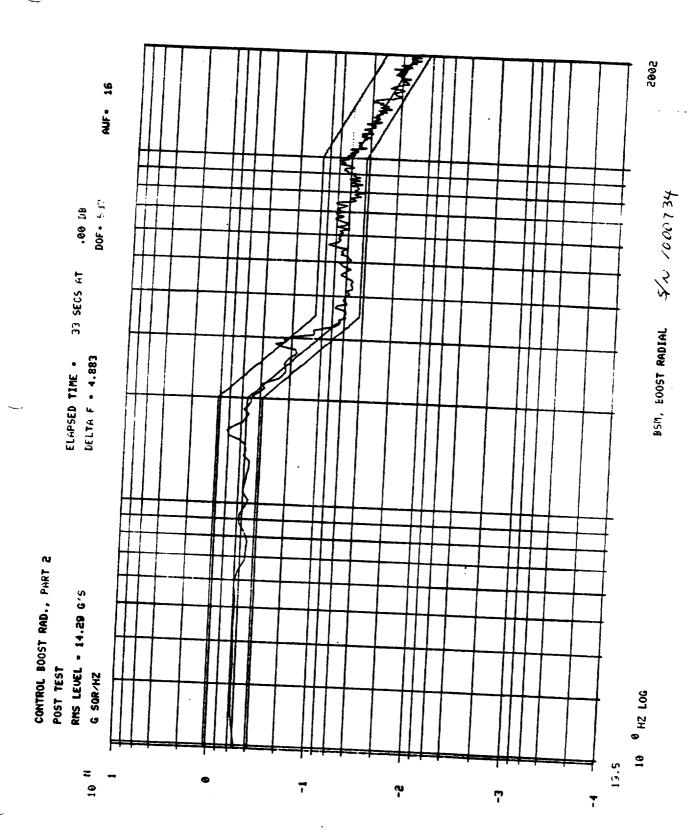


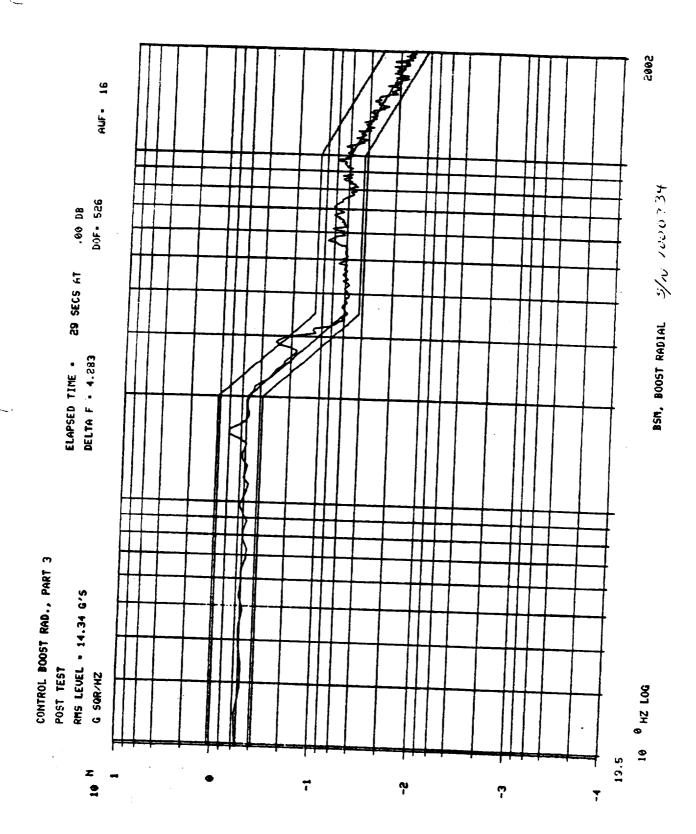


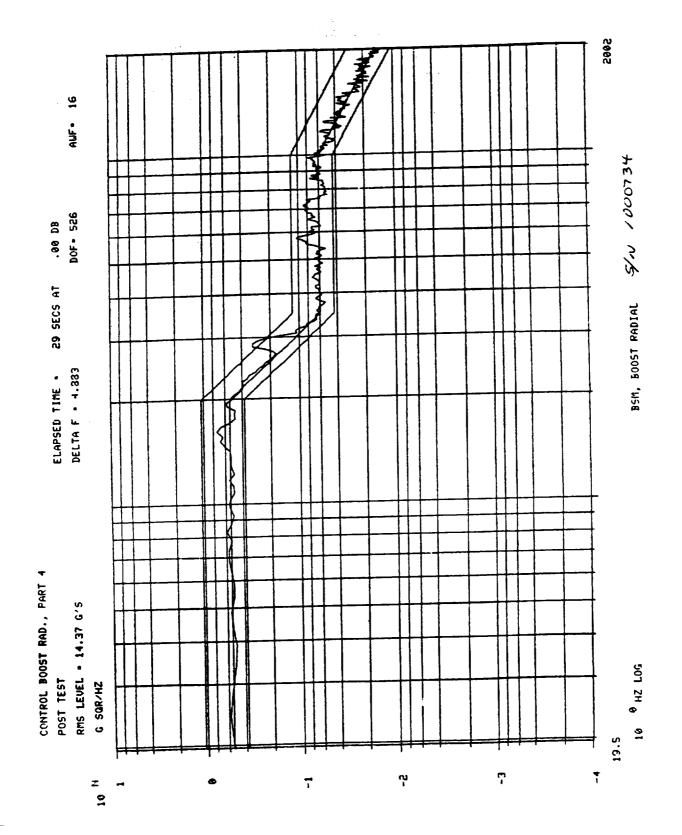


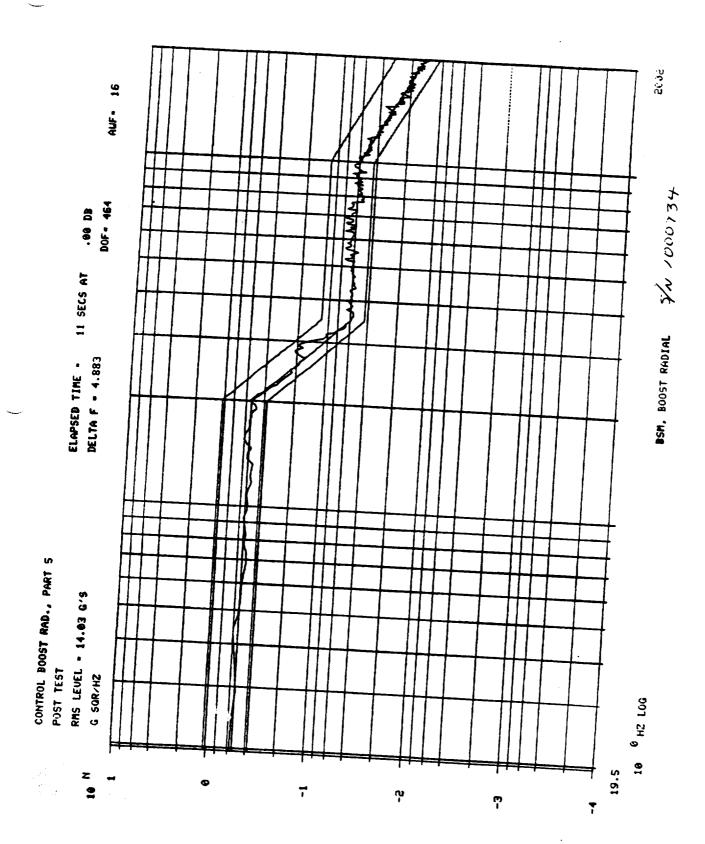
RANDOM, BOOST, RADIAL AXIS



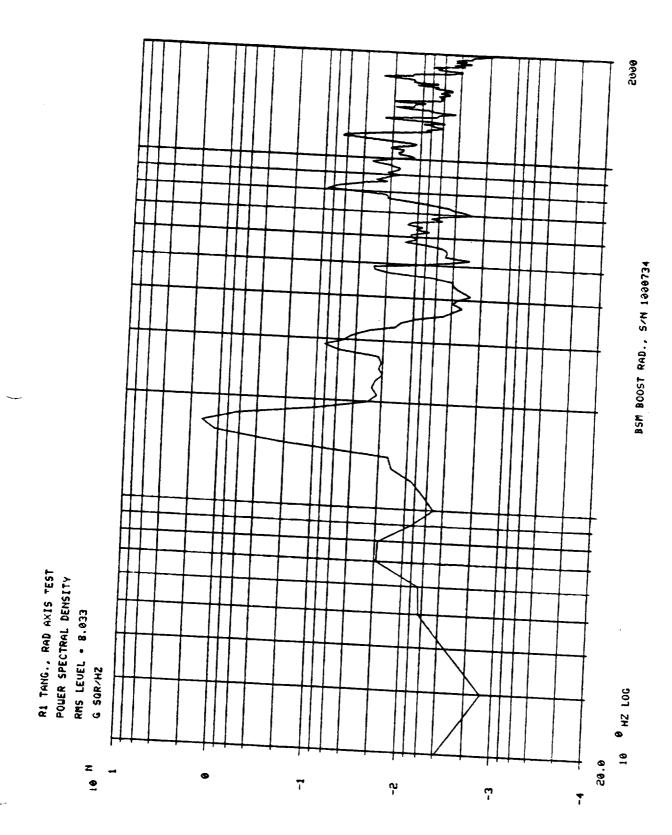


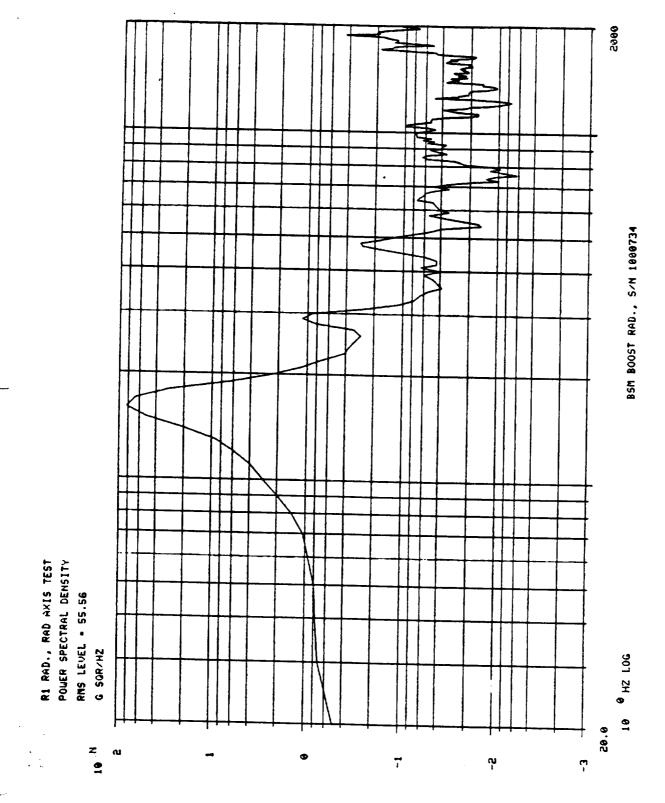






BSM BOOST RAD., S/N 1000734 R1 LONG., RAD AXIS FEST POWER SPECTRAL DENSITY RMS LEVEL - 22.08 G SGR/HZ 10 8 HZ LOG 20.0 2 • 7 ų e.





2000 BSM BOOST RAD., S/N 1000734 POWER SPECTRAL DENSITY RNS LEVEL . 6.349 G SOR/HZ 10 0 HZ LOG 20.0 Z 9 7 ņ ۳ Ţ ķ

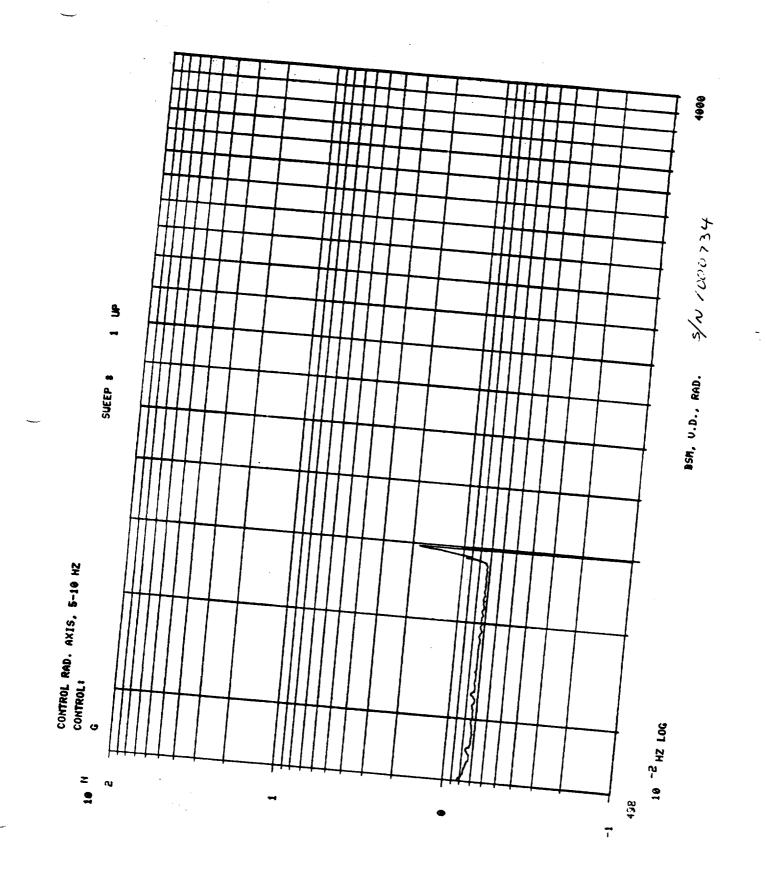
RE LONG., RAD AXIS TEST, BAD DATA, ACCEL CAME OFF

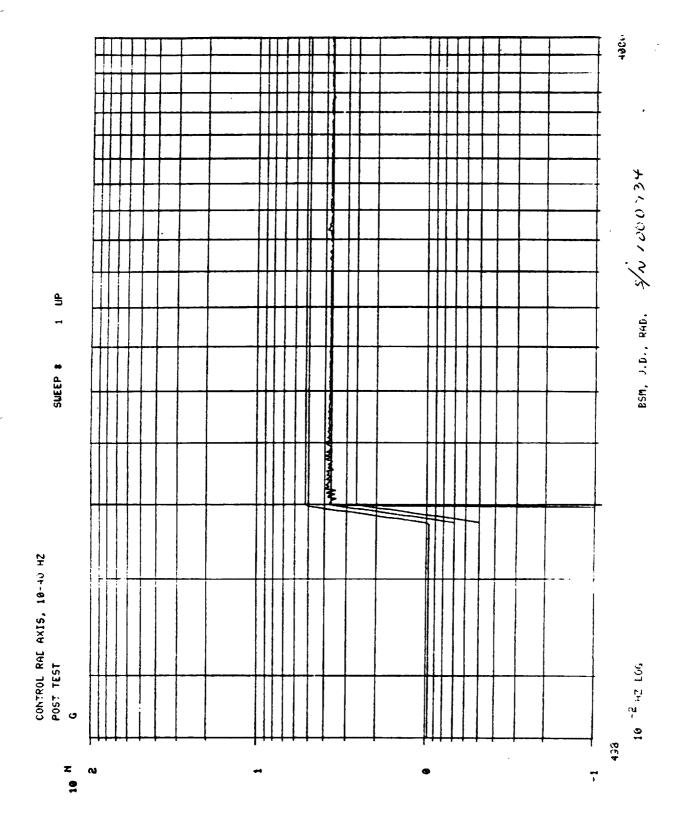
2000 BSM BOOST RAD., 5/N 1008734 RMS LEVEL . 2.551 G SQR/HZ 10 0 HZ LOG 20.0 7 លុ ç ķ 7

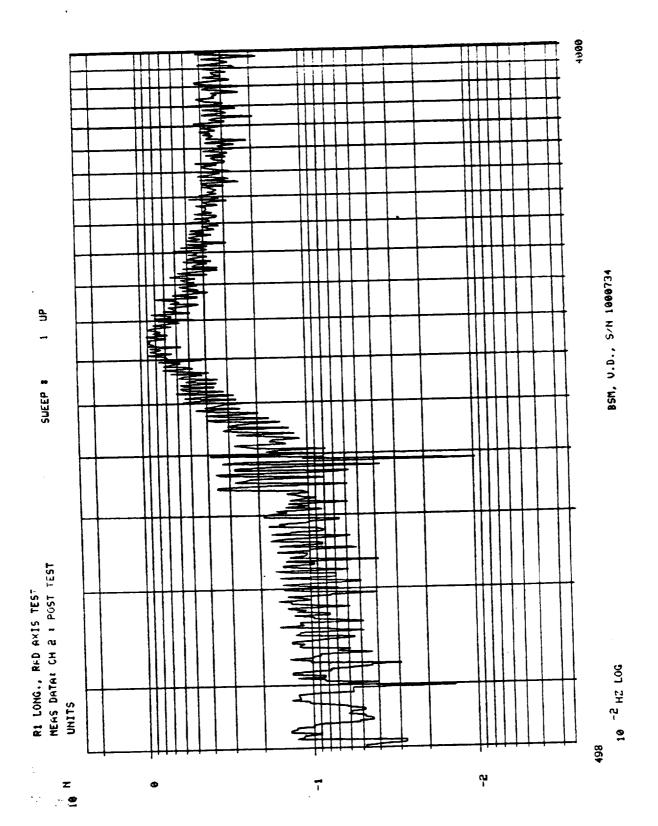
RE TANG., RAD AXIS TEST, BAD DATA, ACCEL CAME OFF POWER SPECTRAL DENSITY

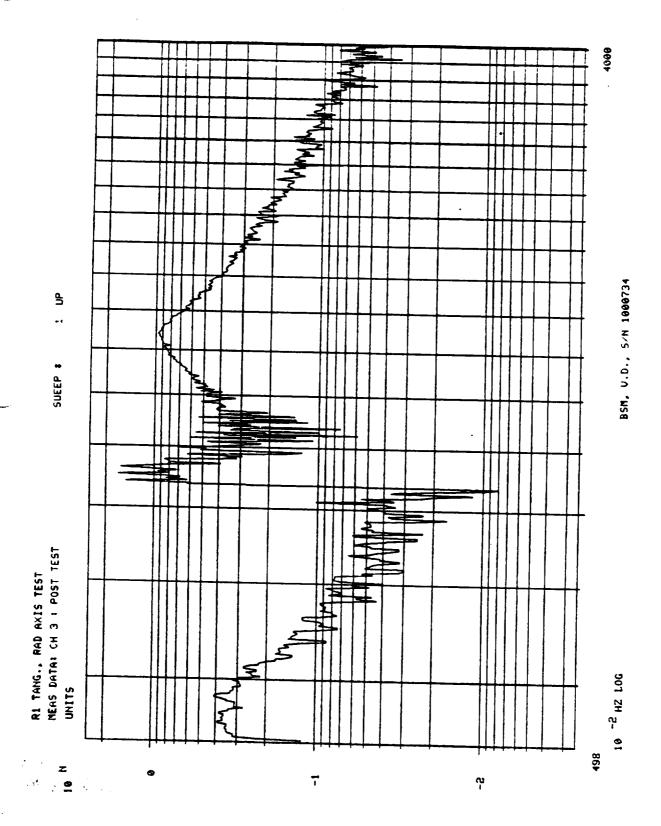
2000 BSM BOOST RAD., S/N 1000734 RE RAD., RAD AXIS TEST, BAD DATA, ACCEL CAME OFF POWER SPECTRAL DENSITY RMS LEUEL . 6.506 G SOR/HZ 9 HZ 100 10 z • 20.0 • 7 ကု ņ

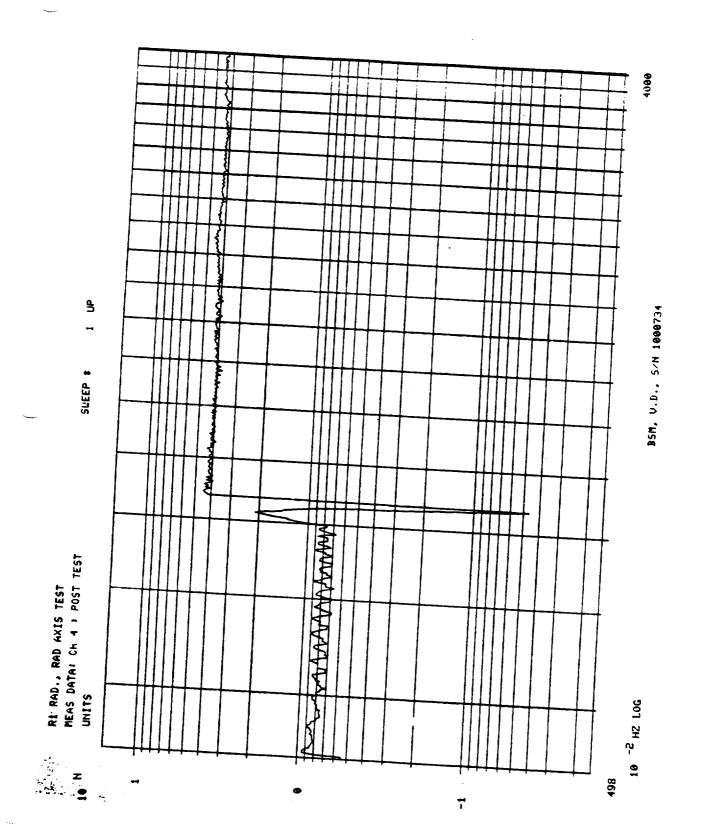
RADIAL AXIS
VEHICLE DYNAMICS

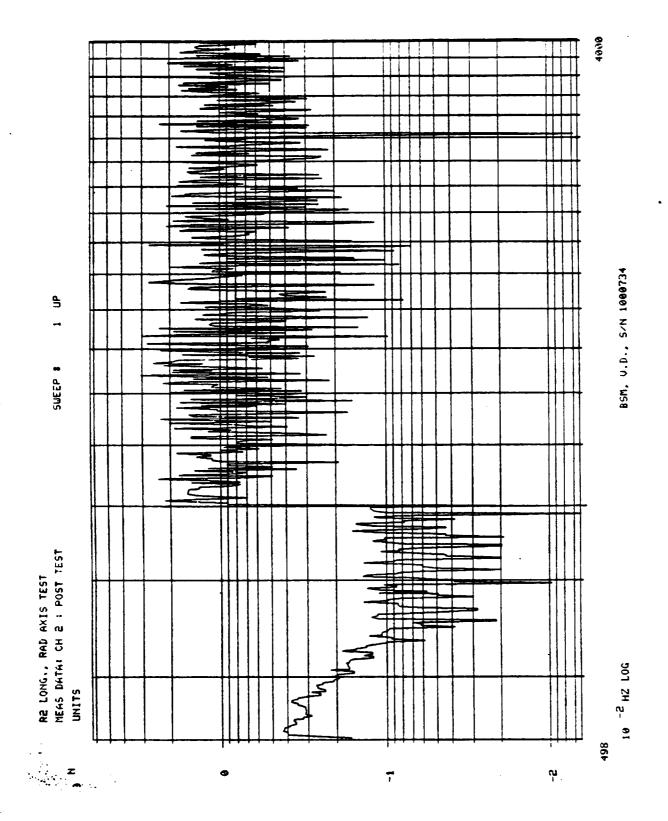


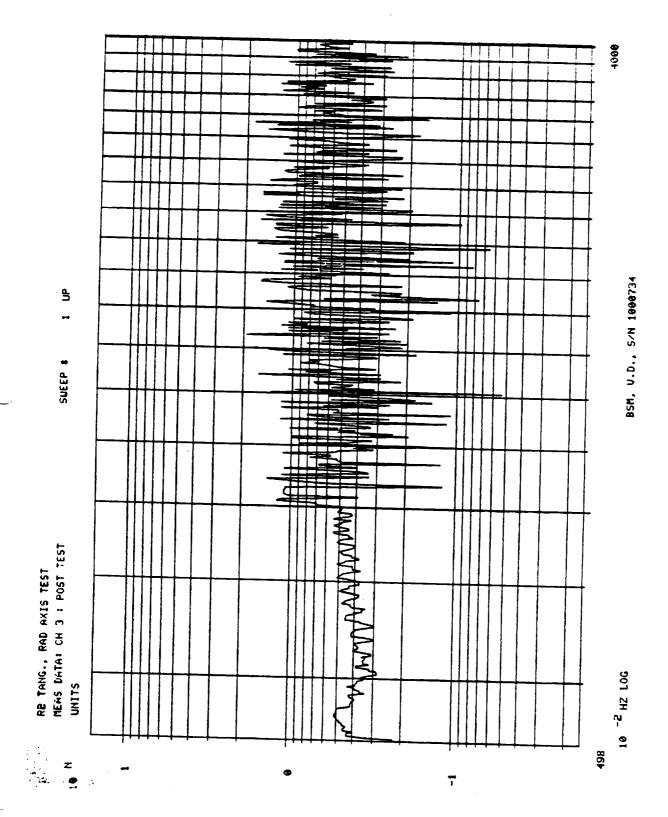


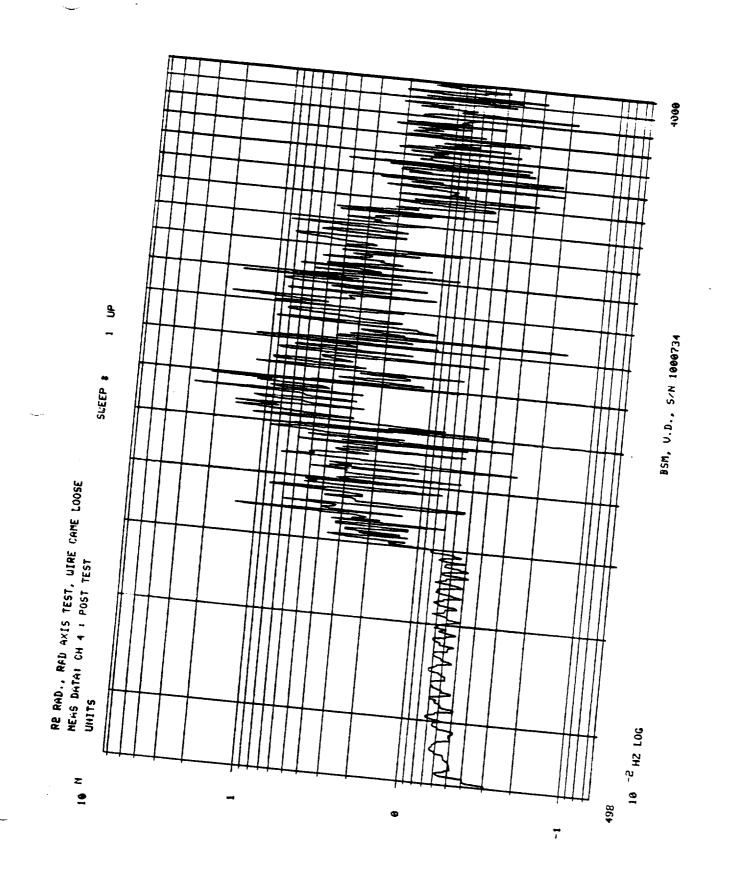


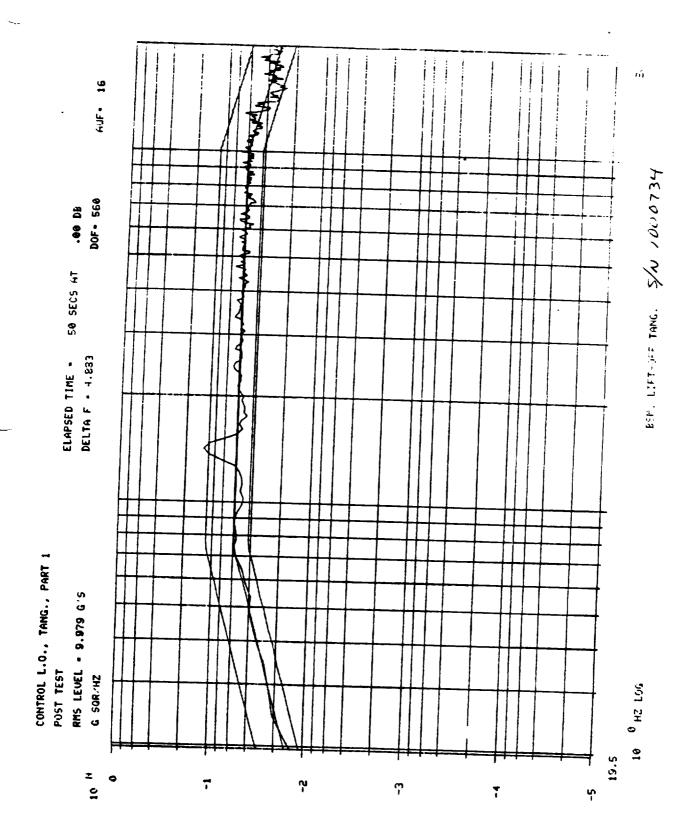


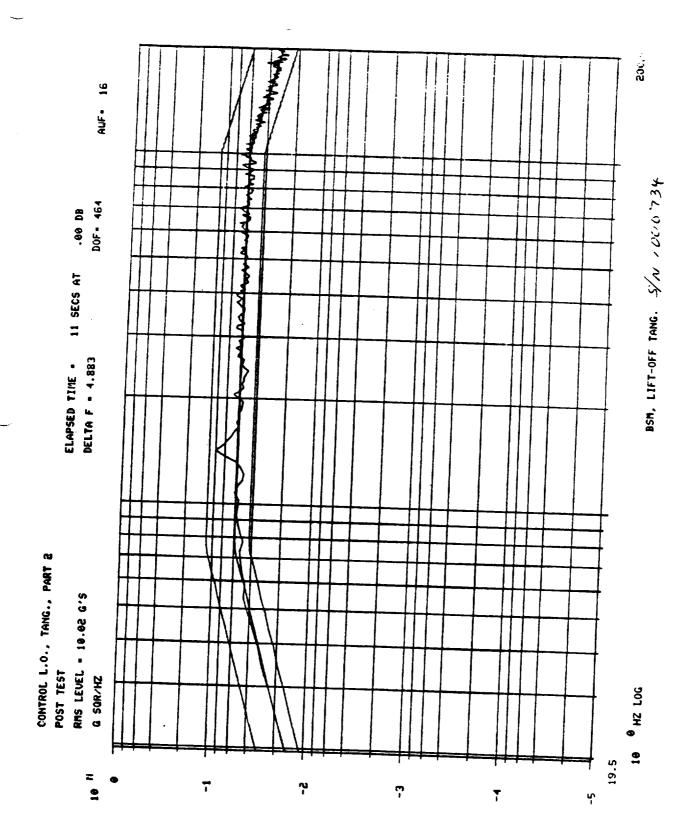




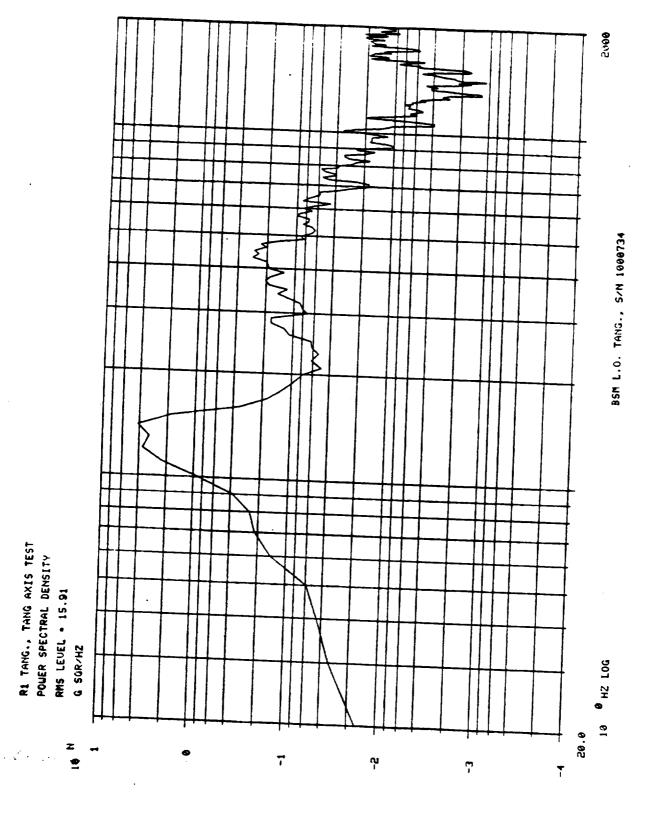


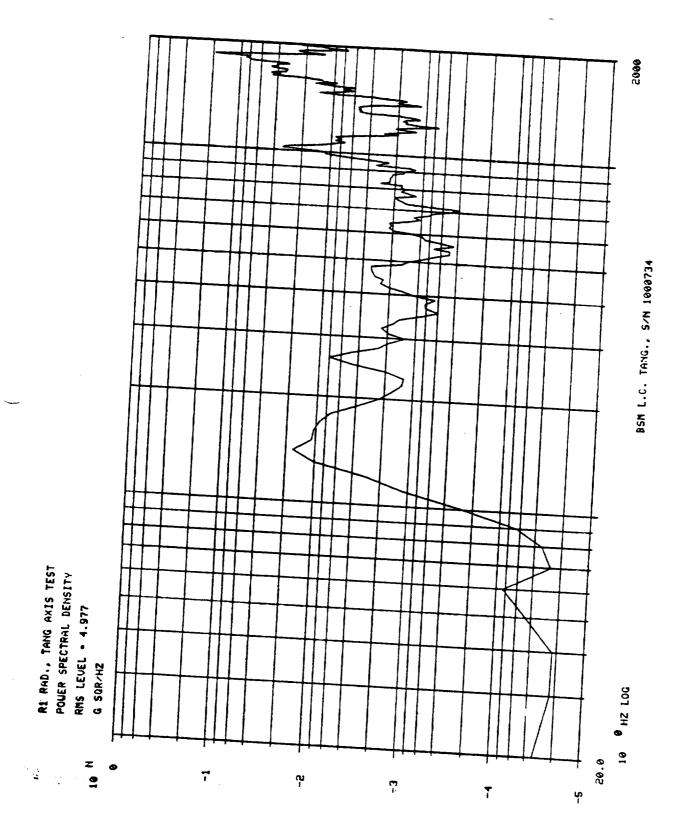






3000 BSM L.O. TANG., S/N 1000734 Rt LONG., TANG AXIS TEST POL R SPECTRAL DENSITY RMS LEUEL - 3.541 G SQR/HZ 10 0 HZ LOG 20.0 z ::: • 7 ç E-7 5



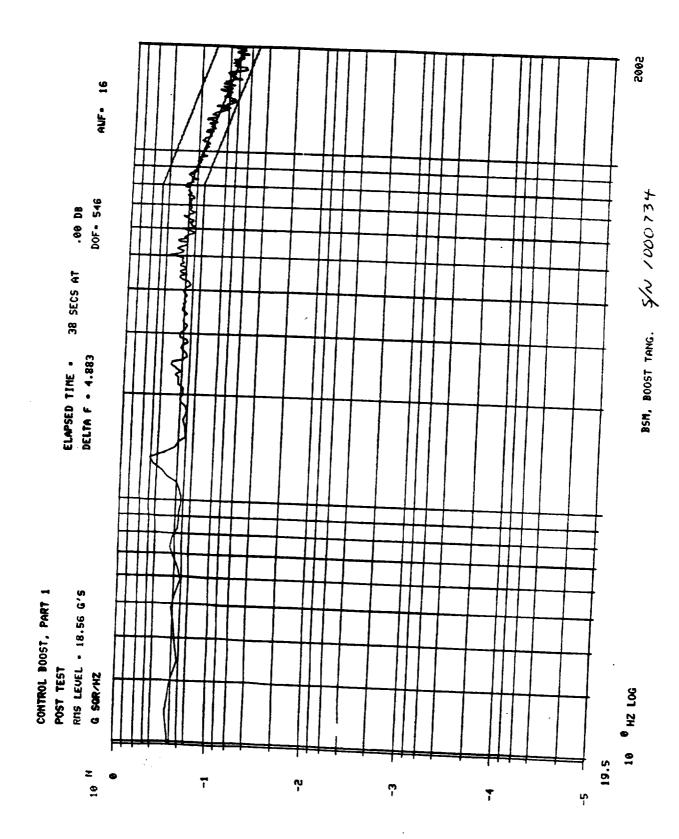


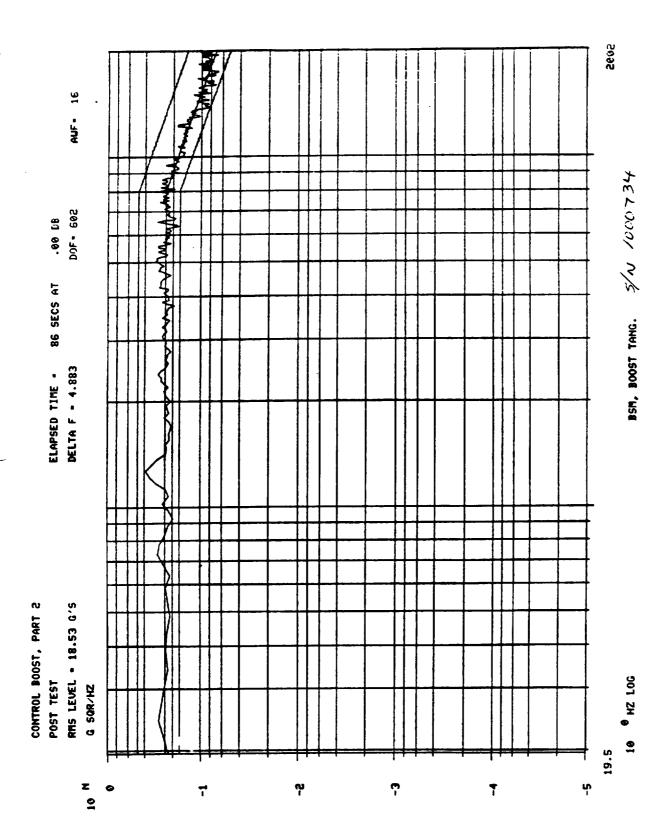
BSM L.O. TANG., 57N 1000734 RA LONG., TANG AXIS TEST POWER SPECTRAL DENSITY RMS LEVEL - 2.187 G SOR/HZ 10 0 HZ LOG 7 ដ ۳ 7 'n

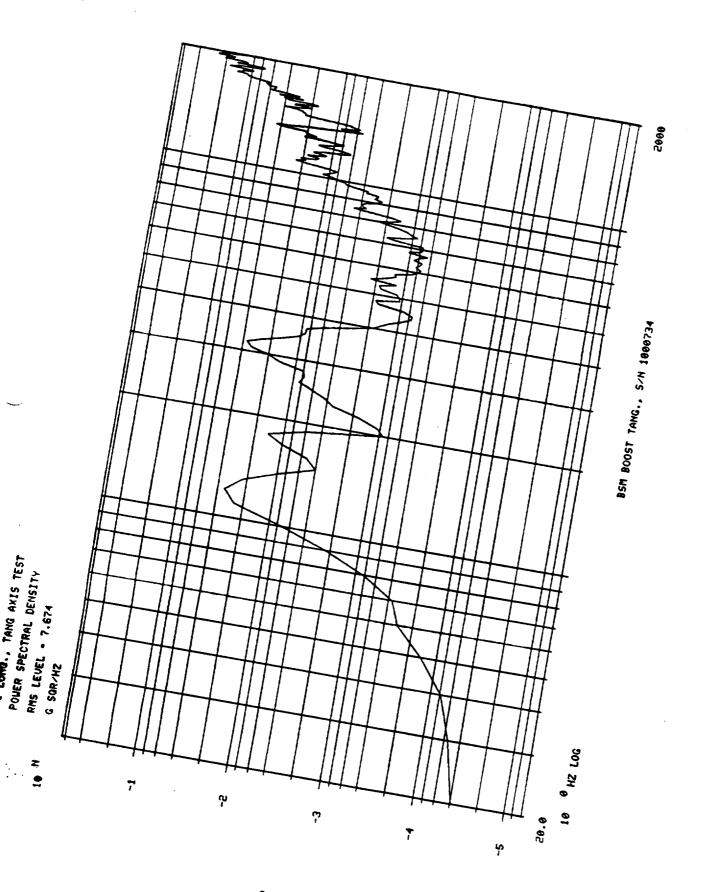
2000 BSM L.O. TANG., S/N 1000734 RB TANG., TANG AXIS TEST POUER SPECTRAL DENSITY RMS LEUEL - 13.79 G SGR/HZ 10 0 HZ LOG 20.0 z • 7 ပ

2999 BSM L.O. TANG., S/N 1008734 RA RAD., TANG AXIS TEST POUER SPECTRAL DENSITY RMS LEUEL . 2.544 G SOR/HZ 10 0 HZ LOG 20.0 z • S, Ę Ŧ 5 7

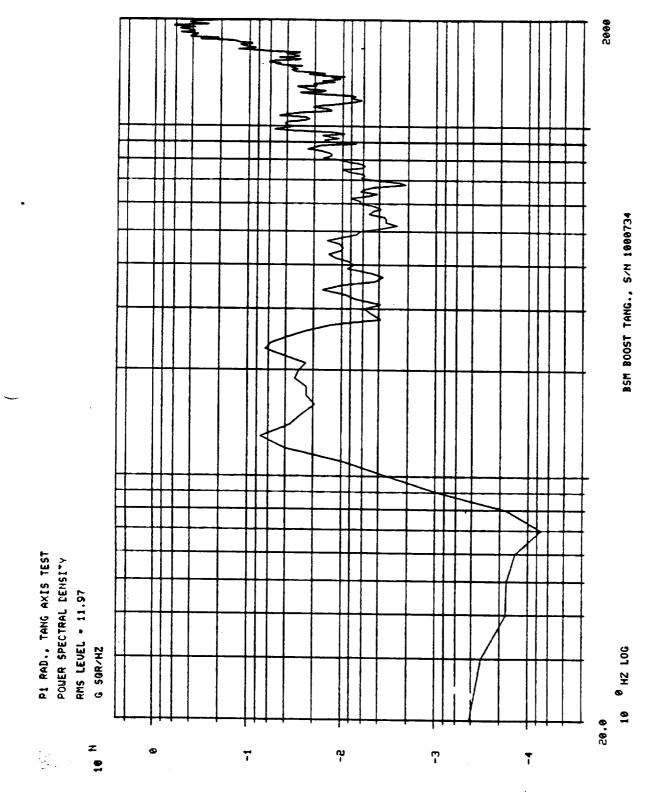
TANGENTIAL AXIS
RANDOM, BOOST

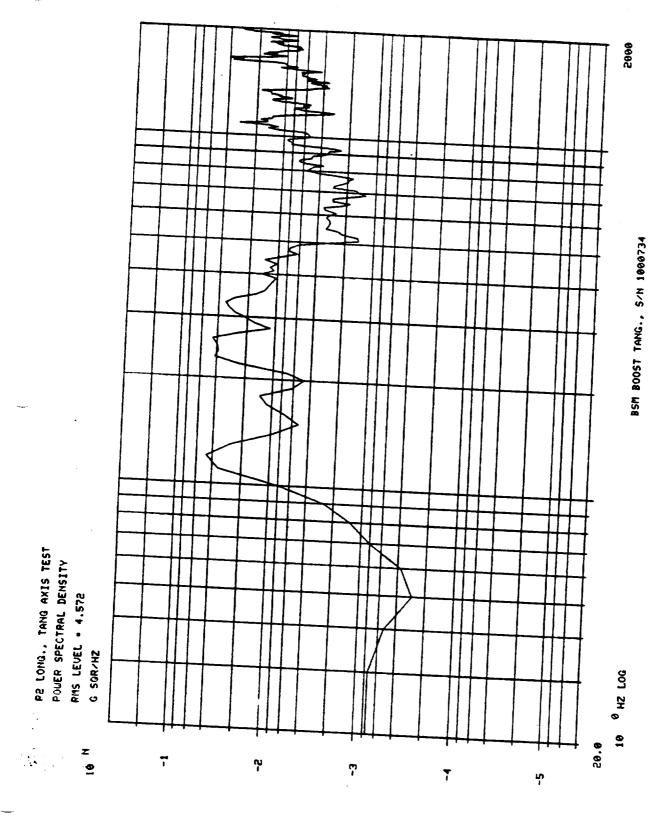






2000 3 BSM BOOST TANG., S/N 1000734 Ri TANG., TANG AXIS TEST Power Spectral Density RMS Level - 89.55 G 50R/HZ 907 ZH 0 10 30.0 7 ကု ç

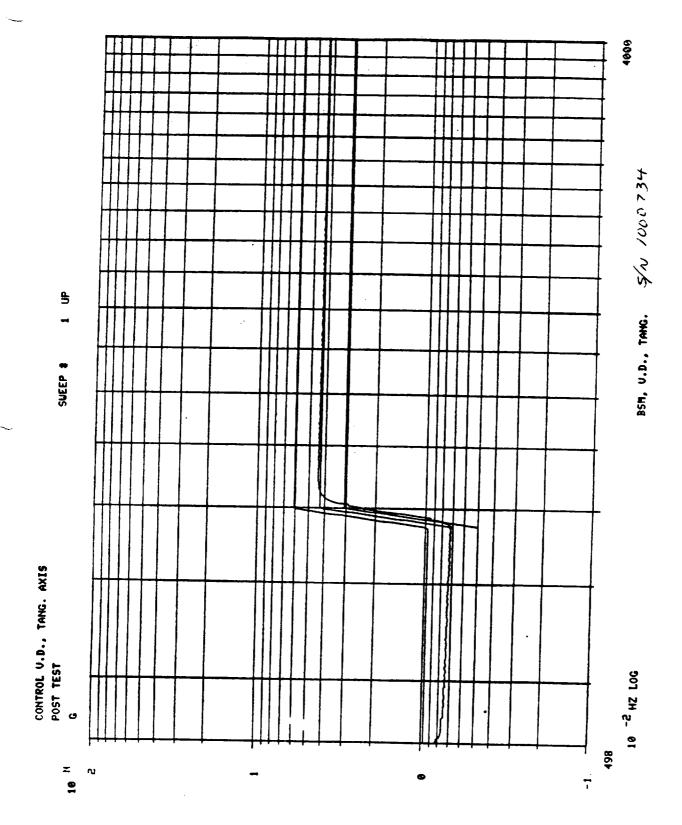


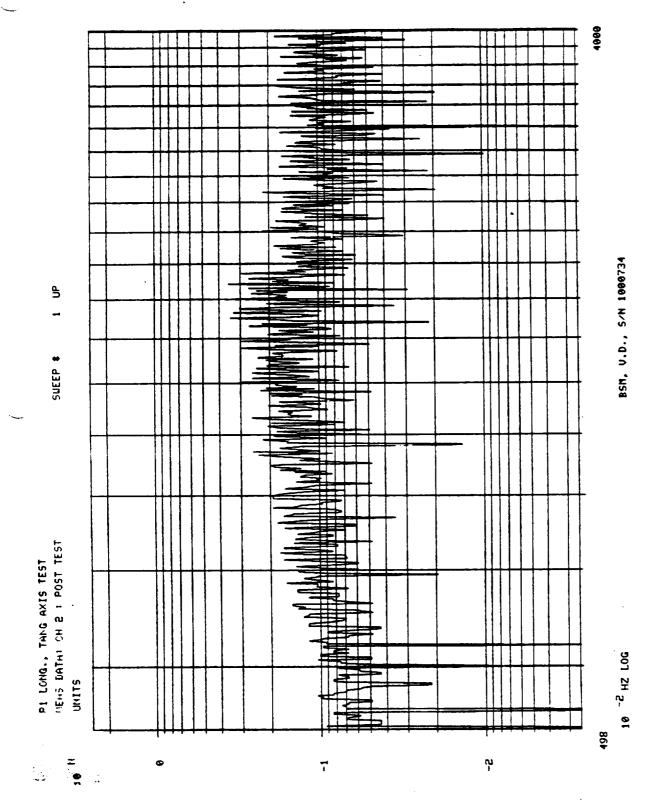


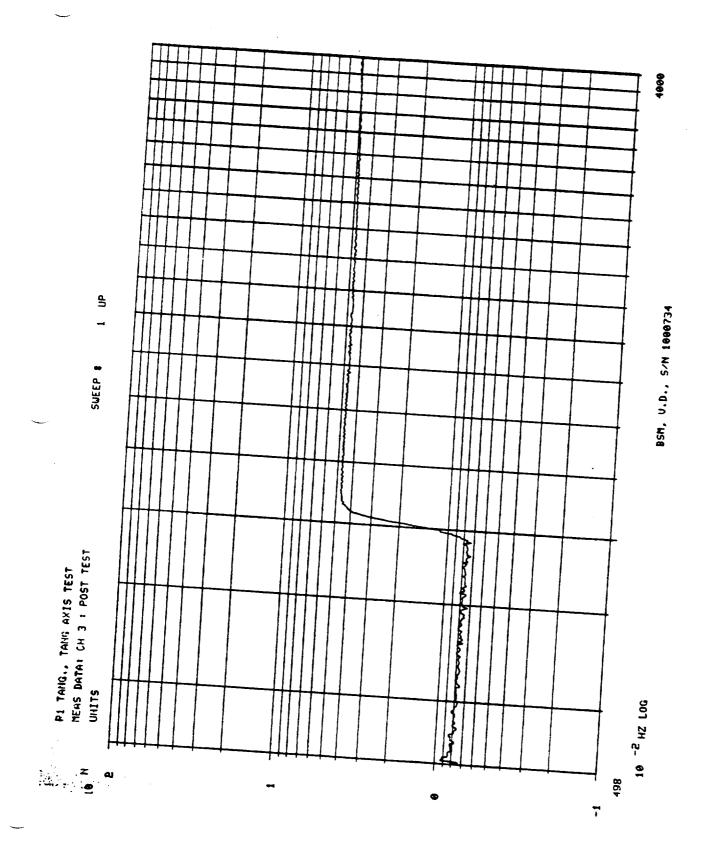
2000 BSM BOOST TANG., 5/N 1000734 RE TANG., TANG AXIS TEST POWER SPECTRAL DENSITY RMS LEVEL - 24.86 G SOR/HZ 10 0 HZ LOG z • 7 ņ

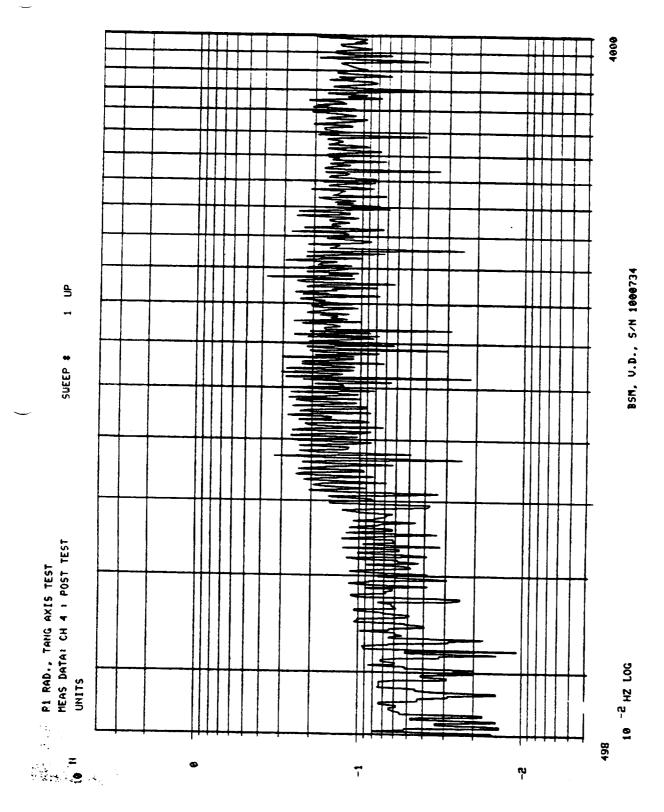
2000 BSM BOOST TANG., S/N 1888734 R2 RAD., THNG AXIS TEST, BAD DATA, ACCEL WIPE LOOSENED POWER SPECTRAL DENSITY RMS LEUEL . 14.21 G 50R/HZ 10 0 HZ LOG 50.0 **≈** N • 7 ដុ

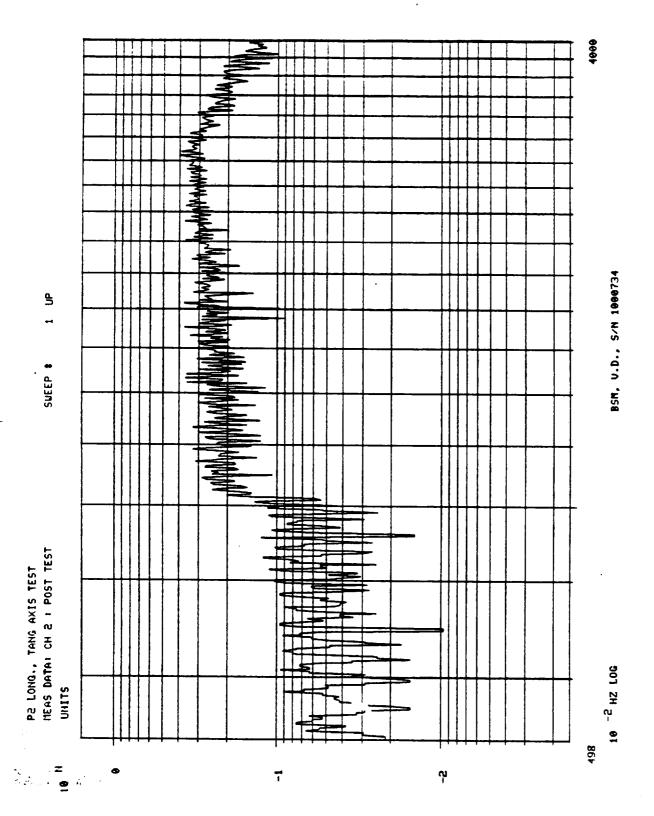
TANGENTIAL AXIS
VEHICLE DYNAMICS

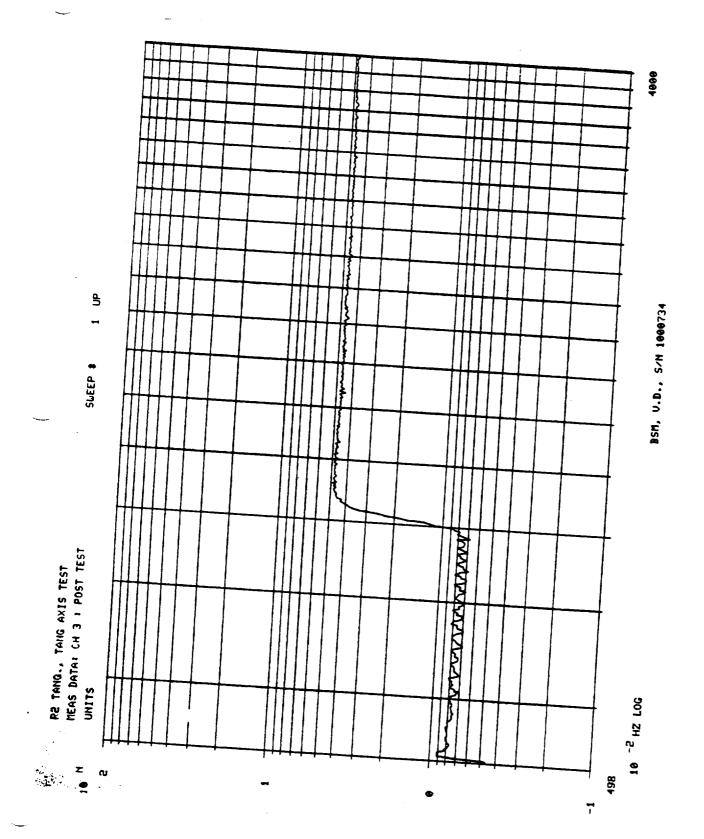


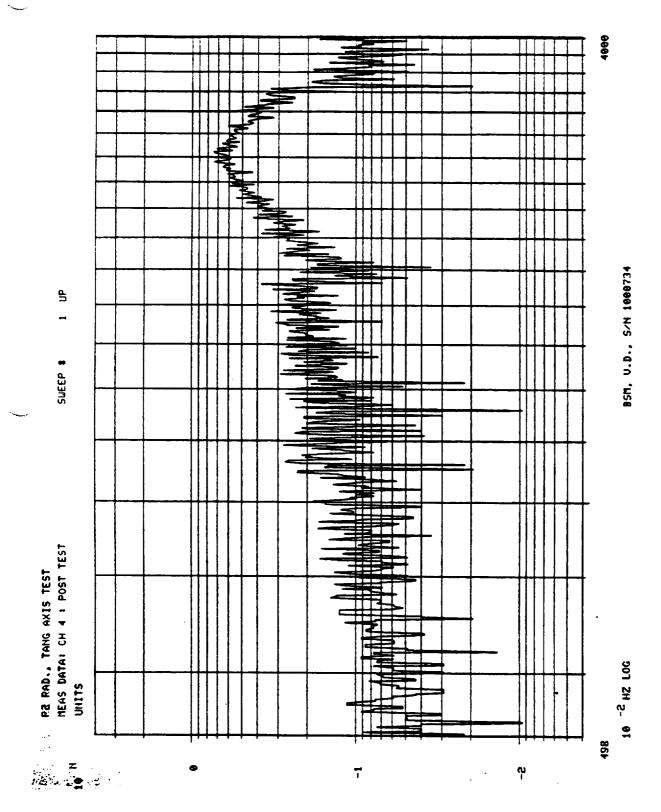




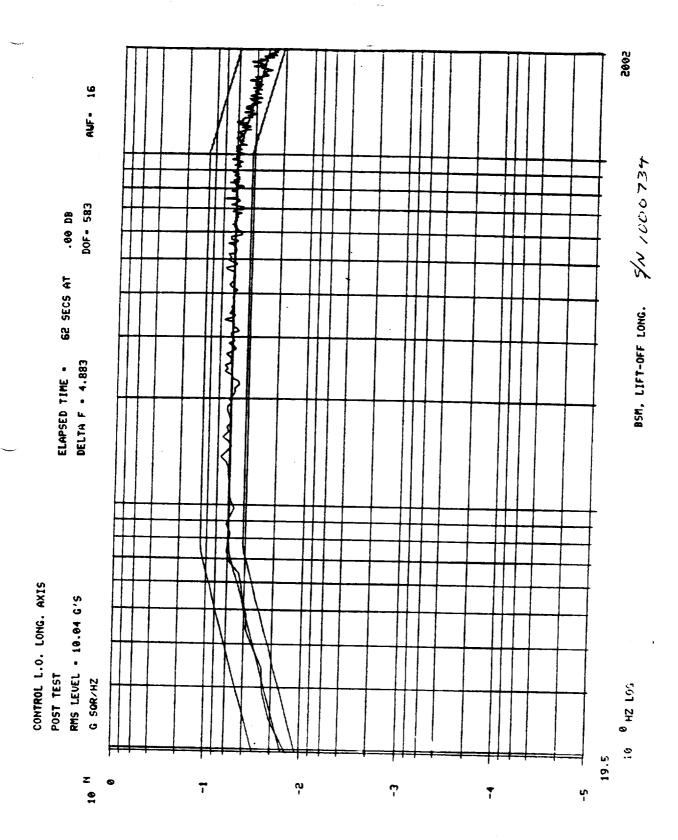








LONGITUDINAL AXIS
RANDOM, LIFT-OFF



2000 BSM L.O. LONG., S/N 1888734 P1 LONG., LONG AXIS TEST POWER SPECTRAL DENSITY RMS LEVEL - 16.91 G 50R/HZ 10 0 HZ LOG • 7 'n Ę

2000 BSM L.O. LONG., S/N 1000734 F. TANG., LONG AXIS TEST POWER SPECTRAL DENSITY RMS LEVEL - 4.355 G 50R/HZ 10 0 HZ LOG Z • 0 7 ល ۴ 7

2000 BSM L.O. LONG., S/N 1000734 P1 RAD., LONG AXIS TEST POWER SPECTRAL DENSITY RMS LEUEL • 13.58 G SGR/HZ 10 0 HZ LOG 7 ų ŗ 7

2000 BSM L.O. LONG., S/N 1000734 PMS LEVEL = 15.40 G SOR/HZ 10 0 HZ LOG 20.0 7 ဂု ç

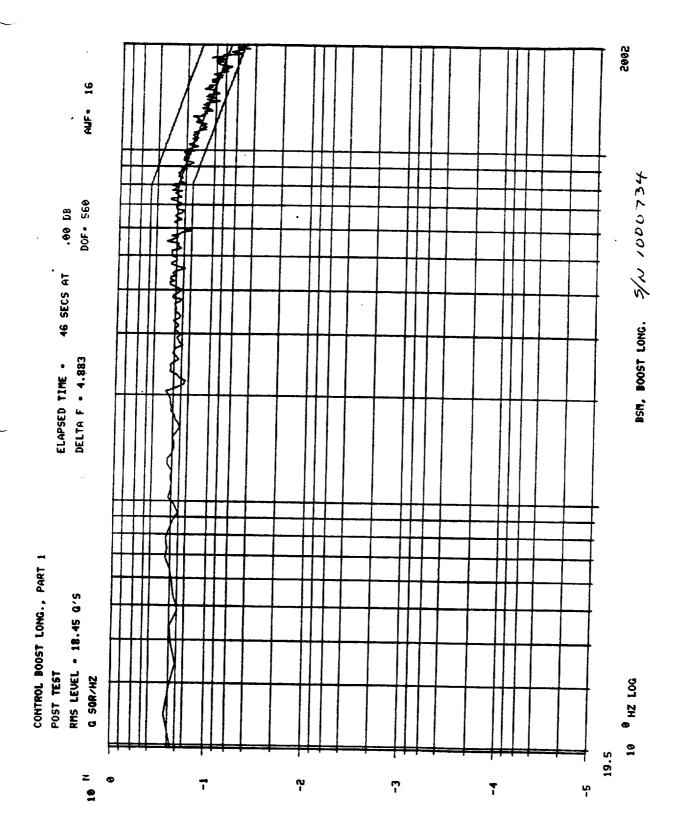
RE LONG., LONG AXIS TEST POWER SPECTRAL DENSITY

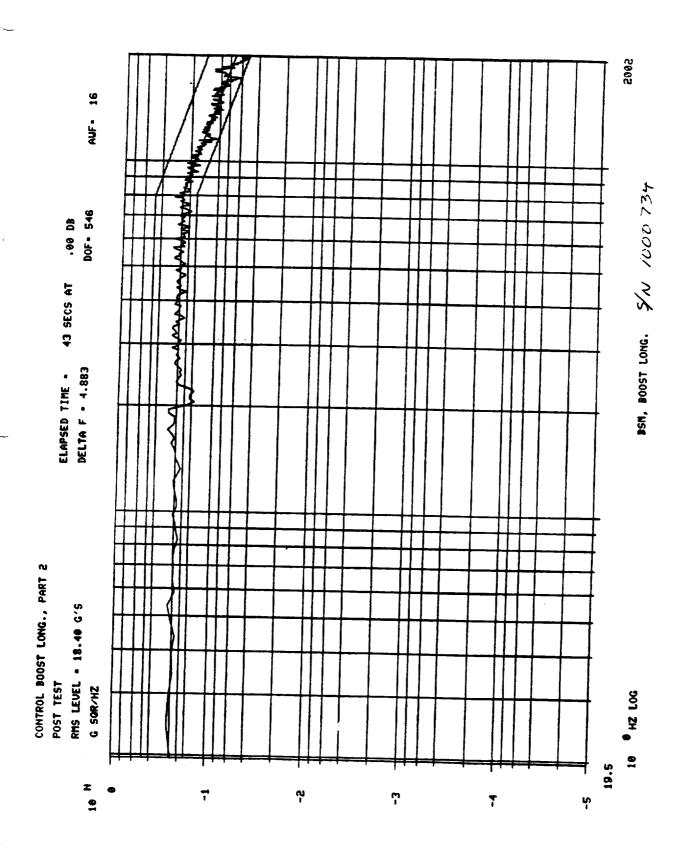
2000 BSF L.O. LONG., S/N 1888734 PE TANG., LONG AXIS TEST POUER SPECTRAL DENSITY RMS LEVEL • 3.520 G SOR/HZ 10 0 HZ LOG 2 9 ī 'n ç 7 'n

BSM L.O. LONG., S/N 1000734 RE RAD., LONG AXIS TEST, BAD DATA, WIRE LOOSE POWER SPECTRAL DENSITY RMS LEVEL • 7.014 G SOR/HZ 10 0 HZ LOG 7 ů ငှ +

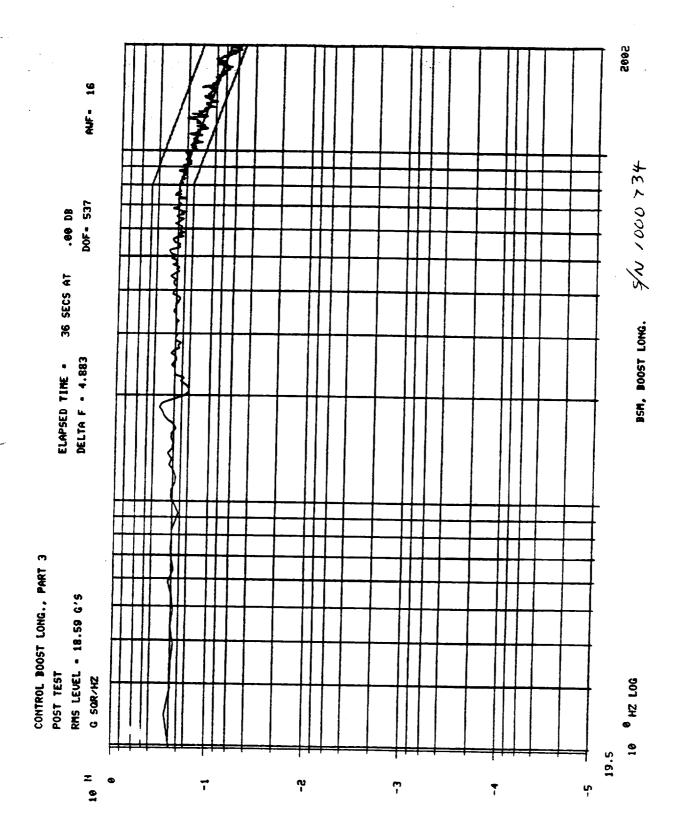
2000

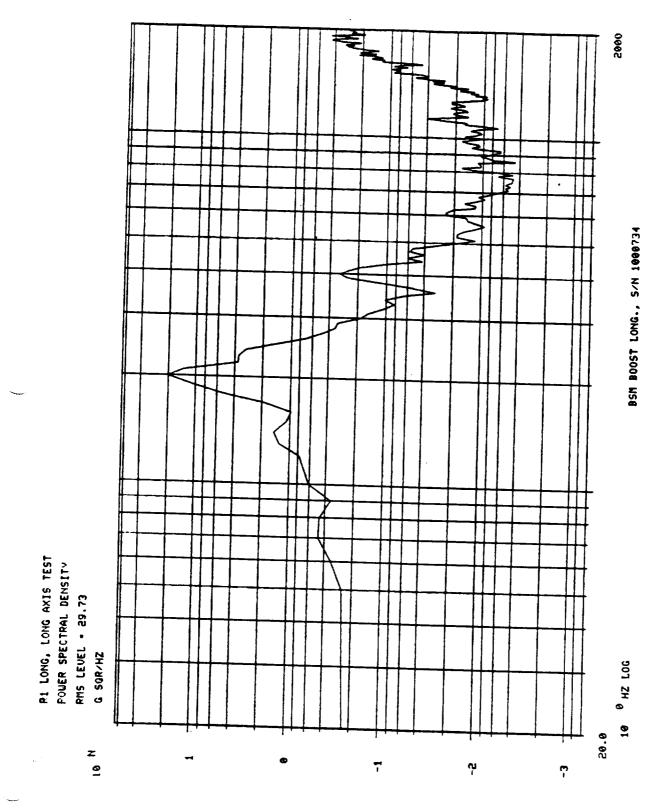
LONGITUDINAL AXIS
RANDOM, BOOST

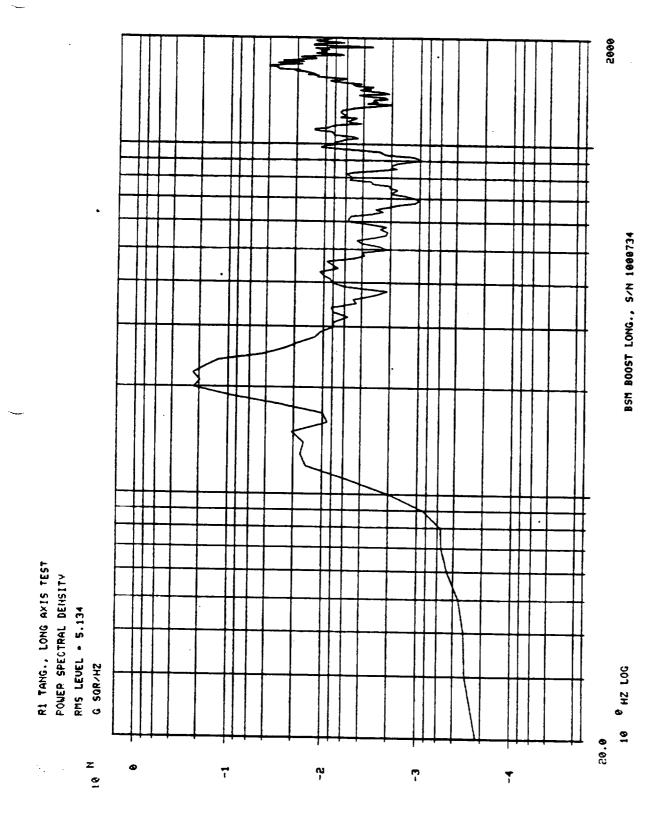




282







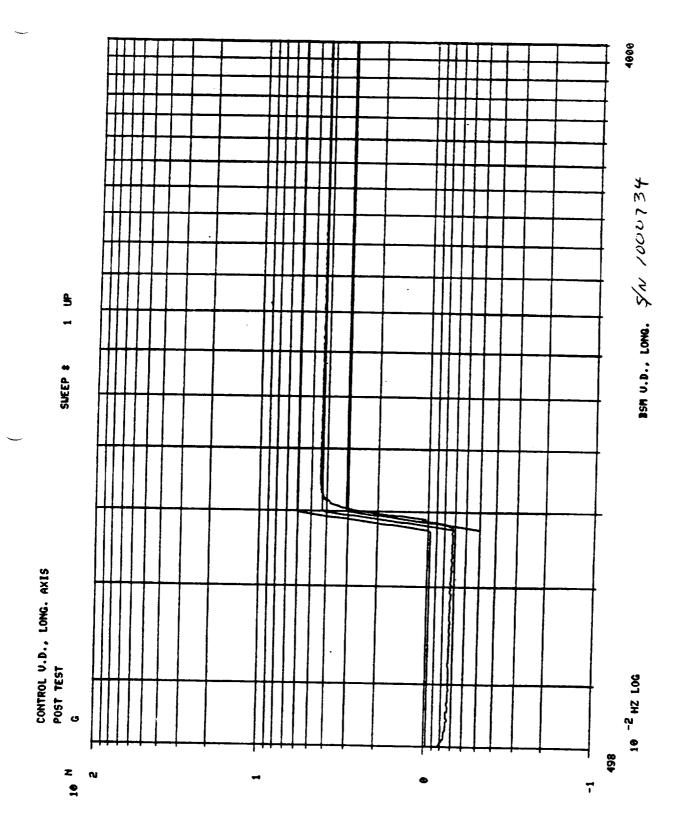
BSM BOOST LONG., S/N 1000734 RI RAD., LONG AXIS TEST POWER SPECTRAL DENSITY RMS LEVEL * 19.34 G.SOR/HZ 10 0 HZ LOG 80.0 Z. 7 ď 6 7

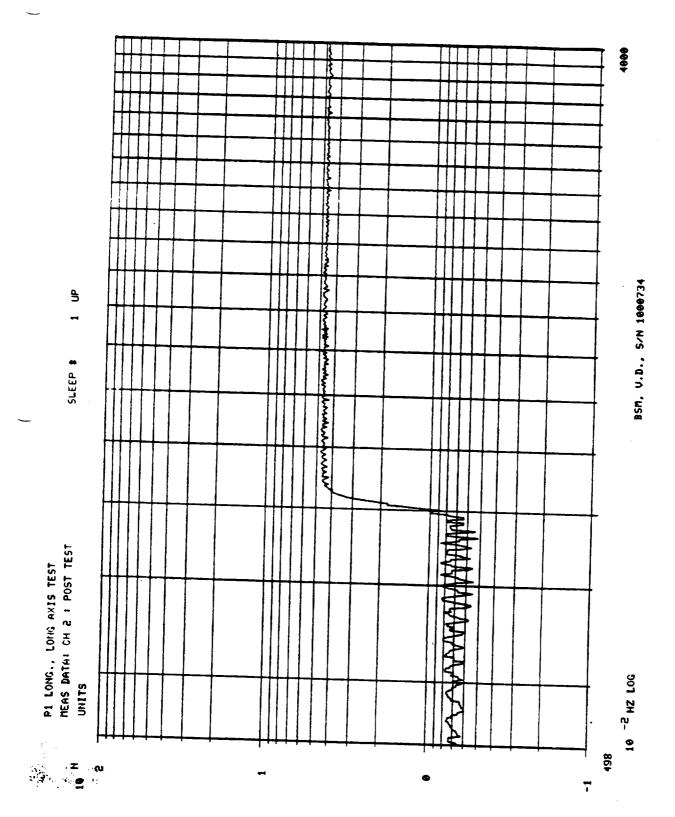
2000 BSM BOOST LONG., S/N 1888734 RE LONG., LONG AXIS TEST POWER SPECTRAL DENSITY RMS LEVEL - 27.43 G SOR/HZ 9 HZ TOG 20.0 Z 9 ហ 7 Ģ

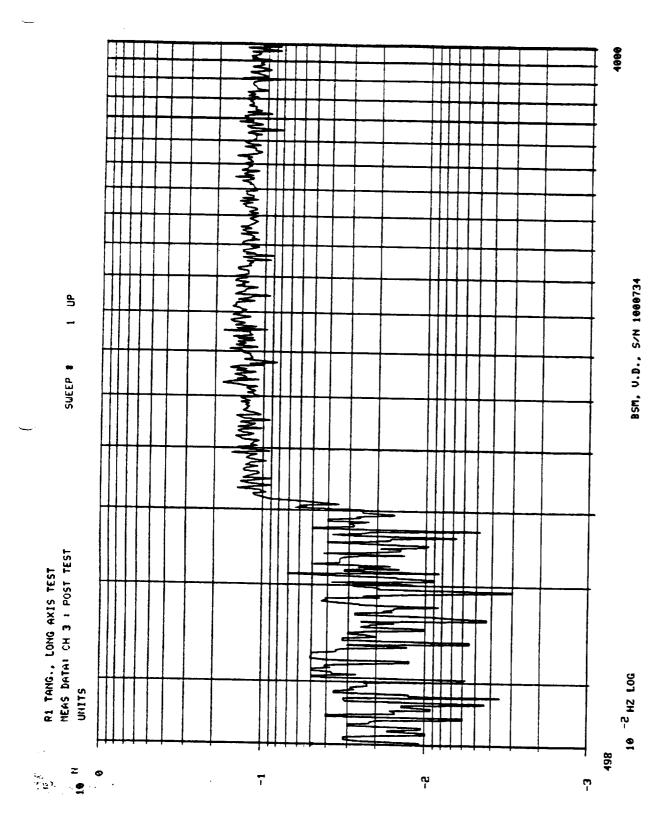
2000 BSM BOOST LONG., S/N 1000734 RZ TANG., LOMG AXIS TEST POWER SPECTPAL DENSITY RMS LEVEL = 3.937 G SOR/HZ 10 0 HZ LOG 60.02 7 ល ñ 7 Š

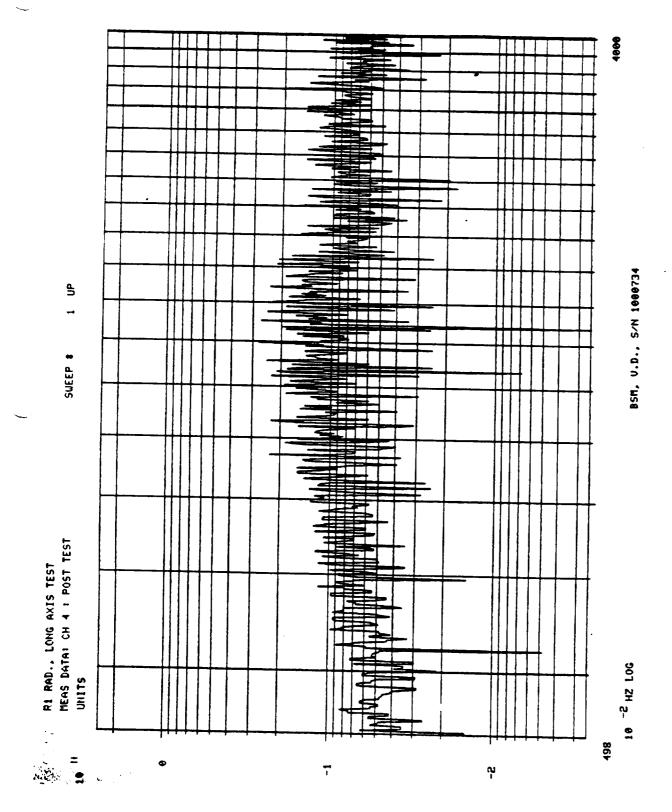
2000 BSM BOOST LONG., S/N 1000734 RE RAD., LONG AXIS TEST,NO DATA, WIRE CANE CFF FOWER SPECTRAL DENSITY
RMS LEVEL - 20.16 G SOR/HZ 10 0 HZ LOG 7 ų Ŧ

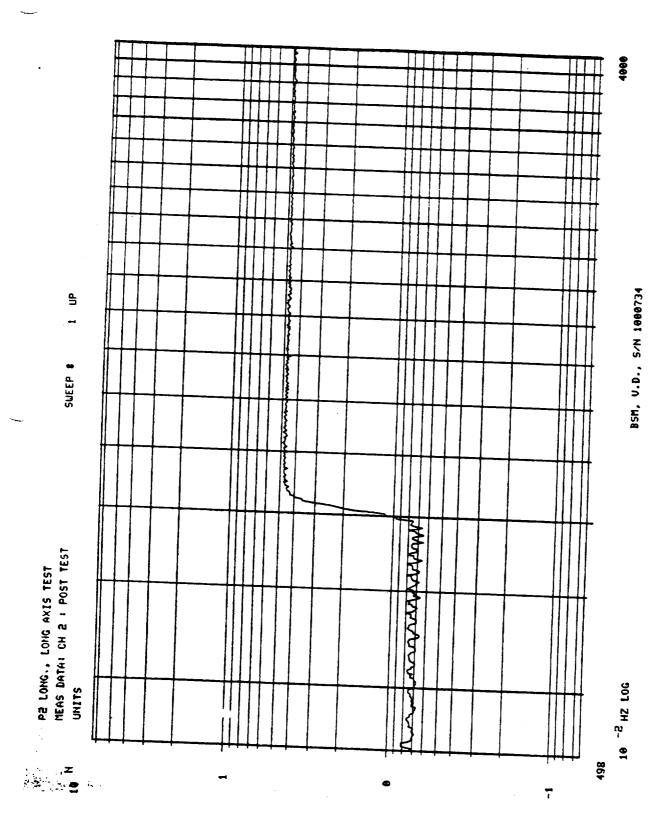
LONGITUDINAL AXIS
VEHICLE DYNAMICS

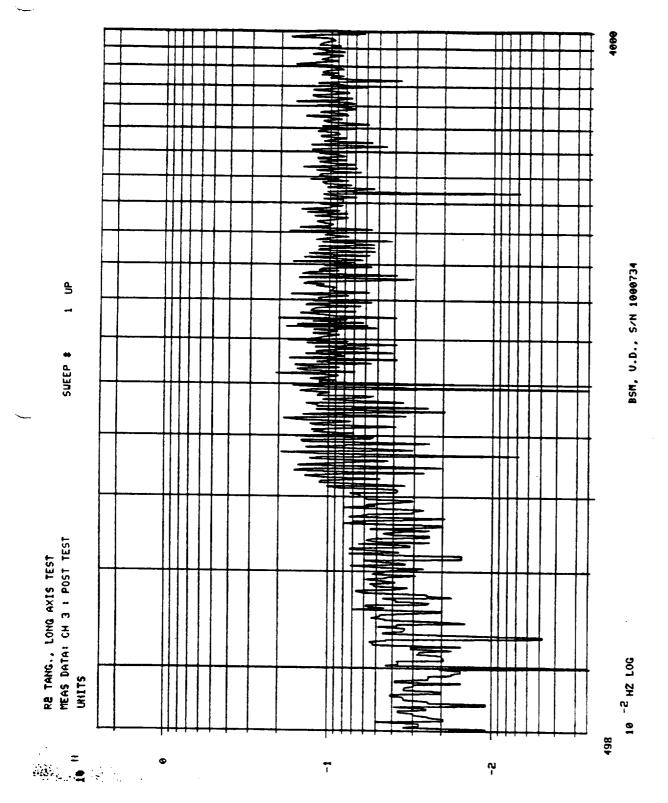


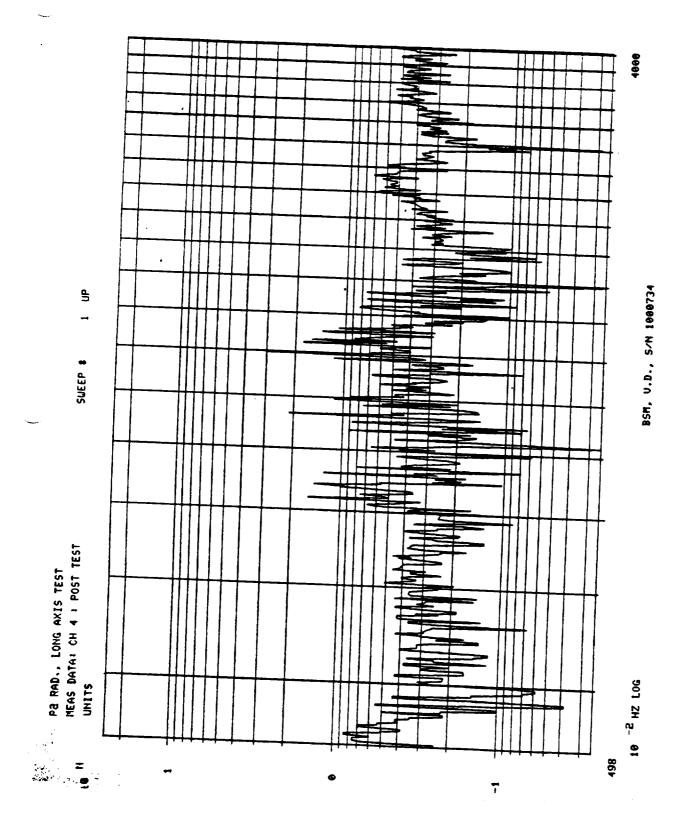












SN 1000738 CHECK OFF LIST

TEST OPERATIONS SET-UP

RADIAL LAMGITUDINA

1.1	Verify proper calibration of instruments to be used.	VVV
1.2	Verify proper calibration of accelerometers to be used.	111
1.3	Install test article on shaker and verify test axis.	111
1.4	Install accelerometer(s) on test article.	111
1.5	Verify continuity from accelerometer(s) to charge	
	amplifier output(s)	1,1

Torque Values:

Test Fixture: 65 ft 65

Test Article: Pen BSM TEST PLAN Shaker Used: UD T-4000

Adapters: Used: MRAD 48 EXPANDER - 2 PLATE (90110063-1)

	TEST OPERATIONS SET-UP	RAVIAL LONGITUDINAL
	AXIS	7.14 C CA 1. 74
1.1	Verify proper calibration of instruments to be used.	<u> </u>
1.2	Verify proper calibration of accelerometers to be used.	<u> </u>
1.3	Install test article on shaker and verify test axis.	V 1 V
1.4	Install accelerometer(s) on test article.	<u> </u>
1.5	Verify continuity from accelerometer(s) to charge	
	amplifier output(s)	VYV

Torque Values:

Test Fixture: 65 ft lbs

Test Article: FER. DIME, TO THAN

Shaker Used: <u>UD T-4000</u>

Adapters: Used: <u>MRAD-48 EXPANDER - 2 PLATE (90M10063-1)</u>

LIFTOFF MANNOM SN 1000738

ls as defined below and verify with plot. cllowing: fier Gain	Record the following:
fier Gain 60%	Record the following:
fier Gain 60%	
	Charge Amp. F.S.
20 Hz 8 .017 G ² /Hz, limits <u>+3</u> ,-	20
- 200 Ez @ .077 " linits "	
- 1200 =z @ .022 " linits _/'	
- 2000 Ez a .010 // limits //	
Ez @ linits	
- <u> </u>	E2
:	
: Hz & limits	<u> </u>
cosite = 6.9 Gras	Composite = 6
Time = 60 Sec.	
T138 =	Test Time =

BOOST RANDOM SN 1000738

RMS abort lim		63	•
Perform levels as de	efined below and	verify with	piot. <u>/</u>
Record the following		,	
Amplifier Gai			
Charge Arp.	F.S. 100	<u>6</u> _	
,			
	•		
	== &	G ² /III,	1:=:== <u>3, /.</u>
<u> 20 ma - 2</u>	.00 Ez e54	<u>+</u>	linits
350 E= - 10	00 =z a .00	6 11	limits
== - <u>20</u>	00 Ez e01	<u>5</u> "	linits
E2	E= 0		limits
	Ez ê	مسيني	linits
	E2 &		linits
EE	E: 8	·	limits
==		•	limits
Composite =	: <u>14</u> GIDS		
Test Time =	120 Sec.		

	NAMICS CHECK-OUT	AXIS 8490
1.1	Verify test program and record the abort level Abort Level	below.
1.2	Perform levels as defined below and verify with	plot.
1.3	Record the fallowing:	
	Amplifier Gain 4070	<i>;</i>
. -	Charge Amp. F.S. 106	·
** **		· · · · · · · · · · · · · · · · · · ·
		. •
•		tdB
	10 - 40 Hz at 3.7 G, limi	t dB
	Hz at,limi	t dB
	Hz at,limi	t dB
	Hz at,limi	t dB
	Sweep Rate = oct/min	
	Test level concurrence:	
	Component Assessment Br	anch Date

303

page of

LIFT OFF RANDOM

Verify test program and re			below.	V
RMS abort limit		_ 43		
Perform levels as defined	below and ve	rify wit	h plot.	<u>v</u>
Record the following:				
Amplifier Gain	70%	<u></u>		
Charge Amp. F.S.	30 G	5		
•	·			
	e <u>.016</u>	G ² /E:,	limits ±	3,-1.
75 Ez - 1000 Ez				
Ez - <u>2000</u> Ez	e <u>.030</u>	11	lizits _	11
E3 32	e		limits _	
Ez Ez	£		linits _	
	e		limits _	
E7 E2	ē		limits _	
E2 E2	ę		limits _	·
	ē <u> </u>		limits _	
Composite = 10	_ Gras			
Test Time = _ 6	Ø Sec.			

BOOST RANDOM SN 10007-8

RMS abort limit		ċ ,3		
Perform levels as defined belo	ow and ver	ify wit	a plot.	· _/
Record the following:				
Amplifier Gain	80.70	-		
Charge Amp. F.S.	1006	-		
•	·			
		G ² /Ξ=,	limits _	+3,-1
<u> 20</u> Hz - <u>800</u> Hz e _	.24	/1	limits _	11
Ez - <u>2000.</u> Ez @ _	.017		limits _	16
E2 E2 @ _			limits _	
E2 E2 @ _			limits _	
			limits _	
Ez Ez Q _			limits _	
Ez Ez @ _			limits _	
== =z	•		limits _	
Composite = <u>18.4</u> Gr	. <u></u> s			
Test Time = 120 s	ec.			

SN 1000 738

HIGLE DYN	AMICS CHECK-OUT		AXI	S TANGENT
2.1.1	Verify test program a	11	level below.	
1.2	Perform levels as def	ined below and verif	y with plot.	<u> </u>
1.3	Record the following:			*.
	Amplifier Gain	40 70		: •
	Charge Amp. F.S.			
		10 Hz at		
		40 Hz at 4.3	,limit	дв
		Hz at	,limit	dB
		Hz at	,limit	dB .
		Hz at	,limit	dB
•:	Sweep Rate = 3	oct/min		•
	Test level concurren	Component Assess	ment Branch	Date

LIFTOFF RANDOM SN 1000738

erify test program		_			
_			• • •	_ •	
Perform levels as d		and ver		: pict.	
Record the following			•		
Amplifier Ga		70%			
Charge Amp.	F.S	306	 -		
	20 Ez a _	.016	G ² /H:,	limits .	+3 -1
<u>75</u> ±= - <u>10</u>					
E=20				lizits	
	== e			linits	
	E: 0			linits	
				linits	
				<u>limits</u>	
Ez				linits	
				limits	
			•		
_	= <u>10</u> GT				
mach mine	= <u>60</u> sa	20.			

BOUT RANDOM SN 1000738

RMS abort lini	.t	<u></u>	
Perform levels as def	lined below and	verify with plo	· <u>/</u>
Record the following:	:	•	
Amplifier Gai:	25		
Charge Amp. F	.s. <u>100</u>		
		•	
	S: 8	G ² /E:, libi	,
<u> 20</u> Ez - <u>80</u>	0 Ez 82		.ts
EE - 200	5 Ez @	17. 1:2:	.ts
	=z e	<u>lini</u>	.ts
Ez	Ez @	lin:	ts
		lin	its
	E2 &		its
	Ez @		its
			<u>:</u> :s
Composite =	18.4 GIES		
Test Time =	<u>/10</u> Sec.		

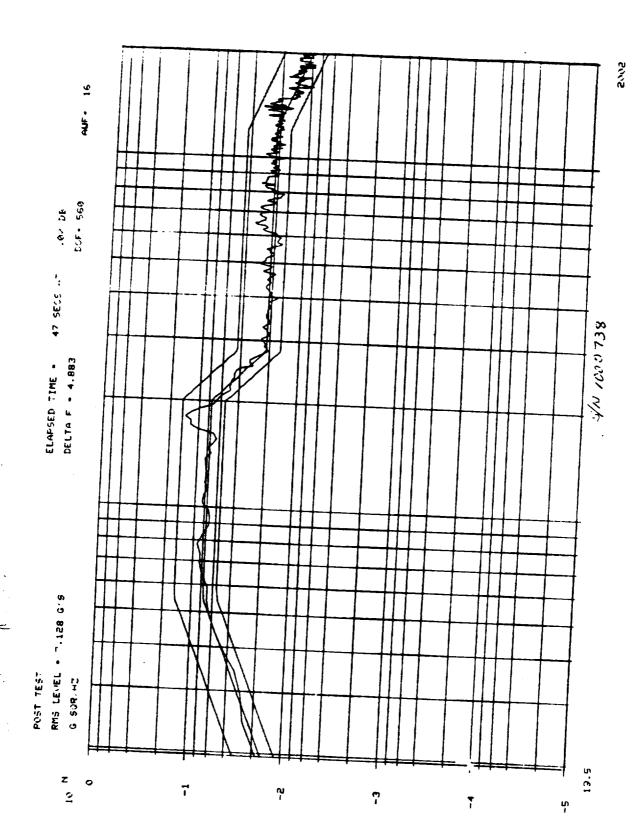
VEHICLE DYNA	AMICS CHECK-OUT	· · · · · · · · · · · · · · · · · · ·	Ŧ		AXIS LONGITUDIO
	Abort Leve		ecord the abort		
1.3	Record the fol		DEIDM SUG AELT	ry with plot.	<u> </u>
en d elle N	•		4070	w for a	
	Charge Amp	. F.S	10.6	· • · · · · · · · · · · · · · · · · · ·	·
	5		Hz at		
			Hz at		
	-	•	Hz at Hz at		
	Sweep Rate =	3	_oct/min		
	Test level co		Component Assess	sment Branch	Date

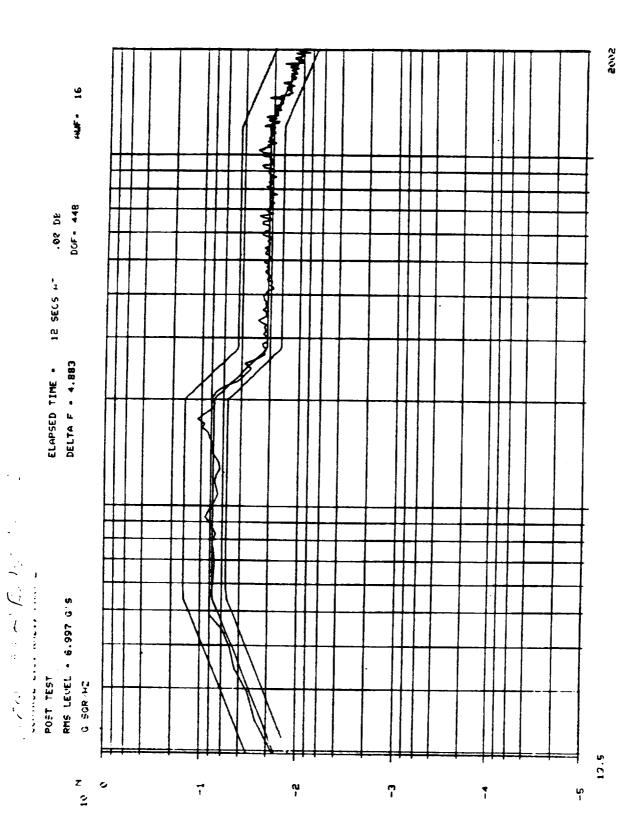
RANDOM TEST LIFT OFF LONGITUDINAL TANGENTIAL. Record a minimum of 30 seconds of calibration signal on .1 tape recorder. VVV Set full scale ranges on instrumentation amplifiers and . 2 note on data sheet. VVV Set power amplifier gain to position noted during random ..3 test check-out. VVV Perform self check of control system. 111 L.4 Begin test sequence at - 9 dB from full level. 111 1.5 At - 6 dB, start tape recorder. 1.6 Note time when full level is reached. JEE TACE LOG 1.7 111 At the completion of the test, set power amplifier gain Y. 8 to off. 111 Stop tape recorder. 1.9 111 Inspect test article for damage or degradation. 1.10 111 Remove test article from shaker. 1.11 111

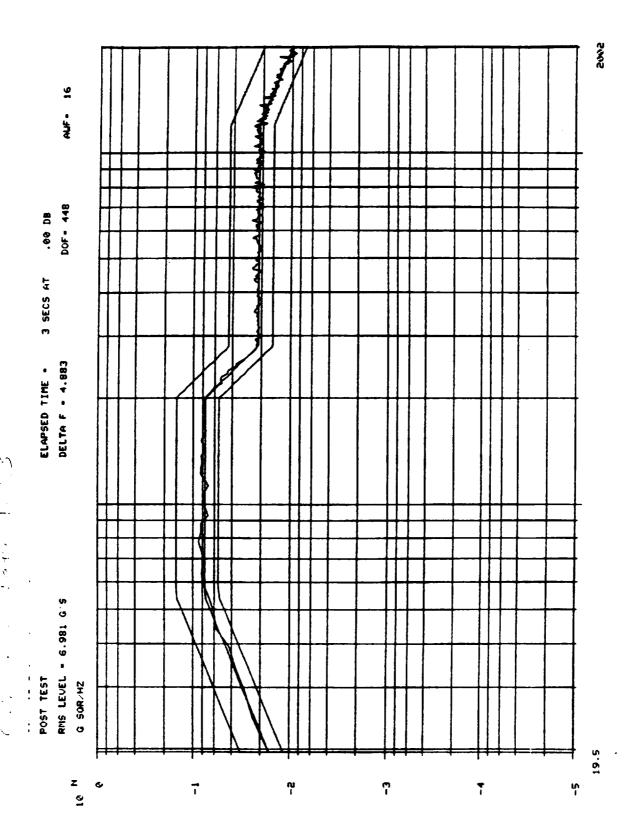
	RANDOM TEST BOOST AXIS	MAUIAL T <u>ANGENTI</u> AL LONGITUDINAL
1	Record a minimum of 30 seconds of calibration signal on	
	tape recorder.	VVI
. 2	Set full scale ranges on instrumentation amplifiers and	
	note on data sheet.	<u> </u>
.3	Set power amplifier gain to position noted during random	
	test check-out.	<u> </u>
.4	Perform self check of control system.	
.5	Begin test sequence at $-\frac{9}{2}$ dB from full level.	1 1 1
6	At - 6 dB, start tape recorder.	41
7	Note time when full level is reached. JeeTHE WG	111
8	At the completion of the test, set power amplifier gain	
	to off.	V//
L.9	Stop tape recorder.	100
L.10	Inspect test article for damage or degradation.	111
1.11	Remove test article from shaker.	<u> </u>

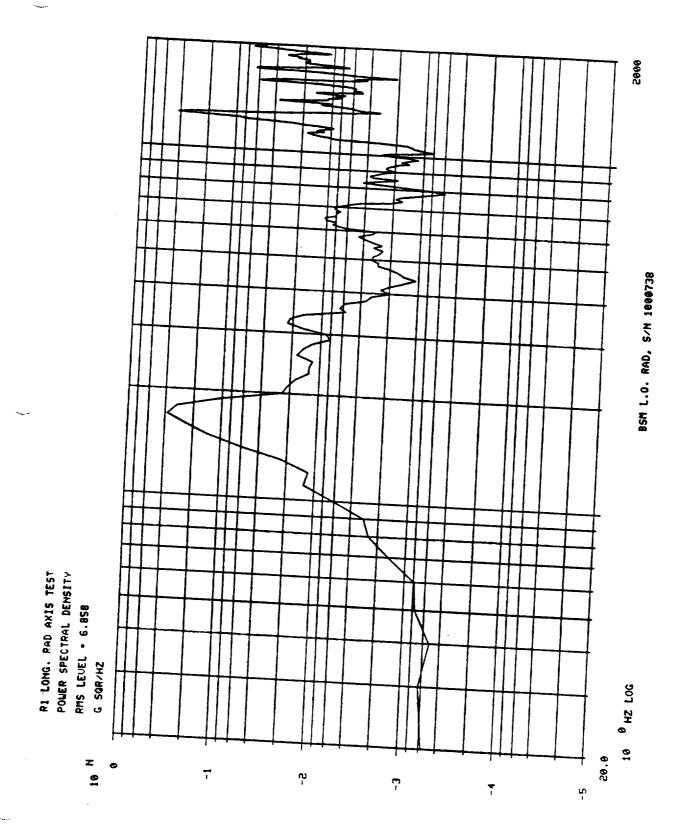
)EHI	CLE	CYNAMICS TEST AXIS	RADIAL TANGENTI
	1.1	Record a minimum of 30 seconds of calibration signal on	
		tape recorder.	× × V
	1.2	Set full scale ranges on instrumentation amplifiers and	
		note on data sheet.	<u> </u>
	1.3	Set power amplifier gain to position noted during sine	
		test_check-out.	VVV
	1.4	Perform self check of control system.	v I v
	1.5	Start tape recorder.	~//
	1.6	Begin sine sweep.	× × ×
	1.7	Note time of DCS "SWEEP UP" or "SWEEP DOWN" indication	
		light. <u>See TAPE 106</u>	- 1 v
	1.8	During first sweep, press the "SAVE" button on DCS.	p 1 y
- ·	1.9	If more than one sweep, note time of DCS "SWEEP UP" or	
		"SWEEP DOWN" indication light.	
	1.10	At the completion of the sweep, set power amplifier	
•		gain to off.	· J V
	1.11	Stop tape recorder.	VV
	1.12	Inspect test article for damage or degradation.	<u> </u>

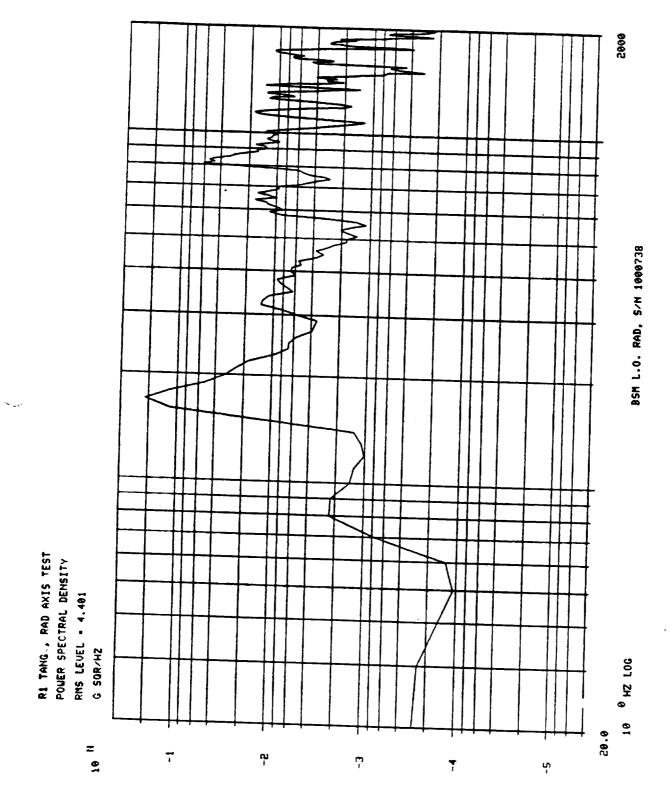
SN 1000738 Test Data RADIAL AXIS
RANDOM, LIFT-OFF



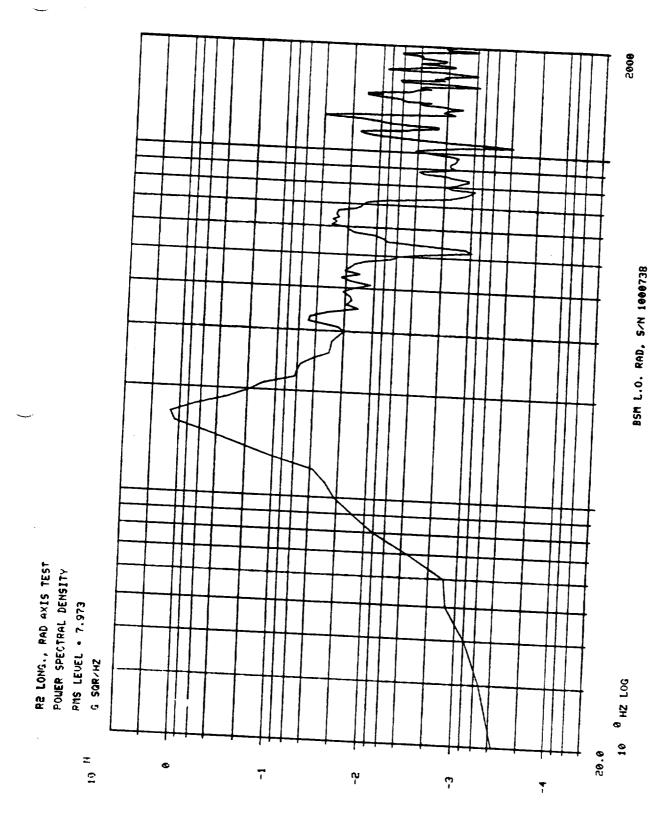


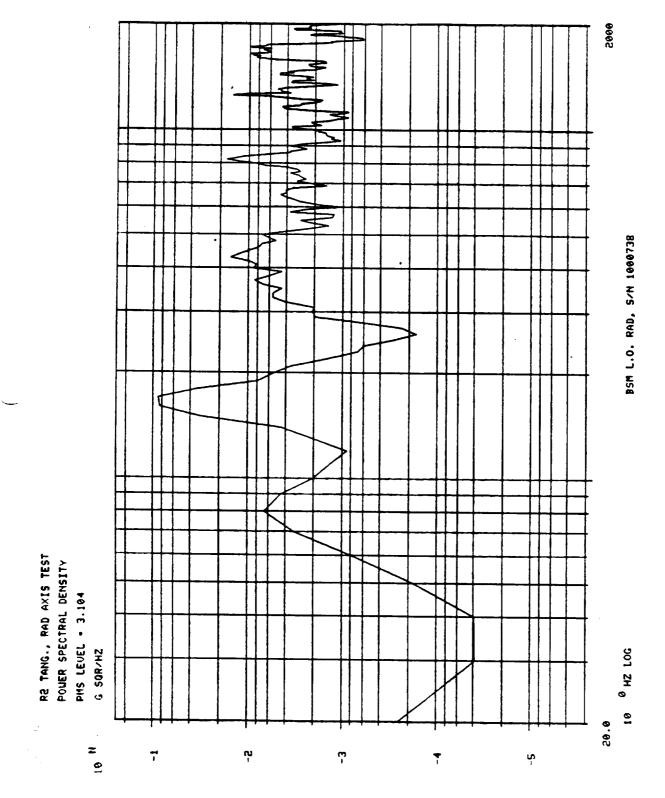


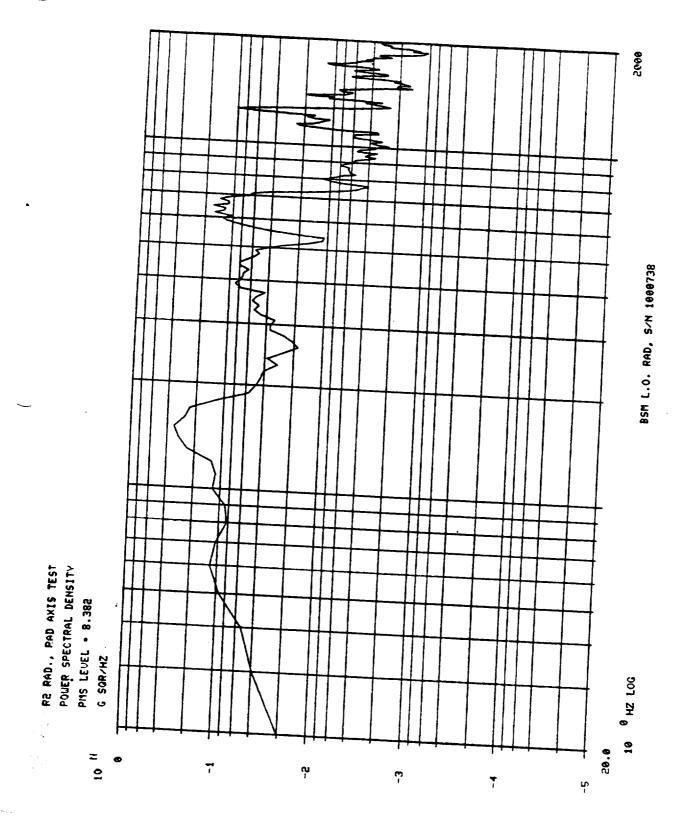




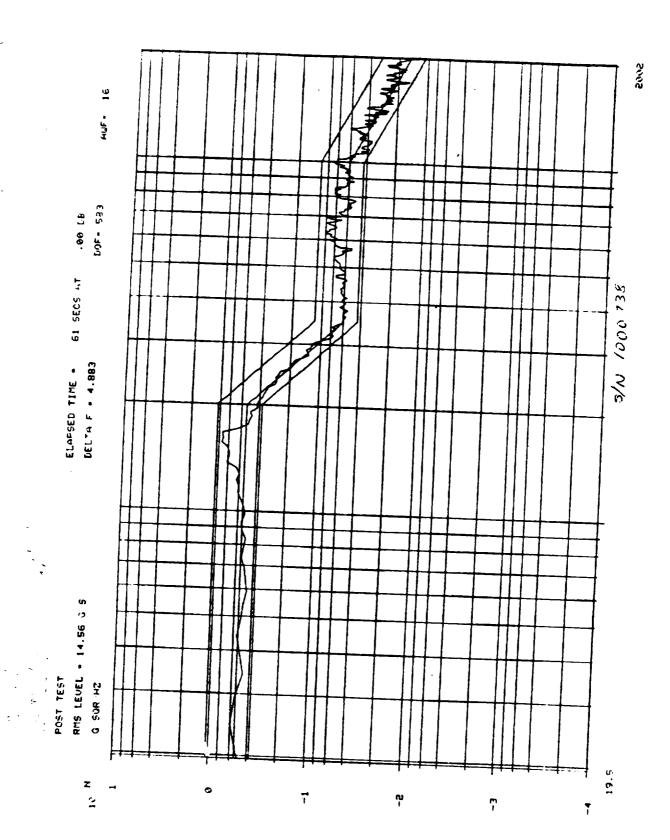
BSM L.O. RAD, S/N 1000738 RI PAD., PAD AXIS TEST POWER SPECTRAL DENSITY PMS LEVEL - 15.28 G SGR/H2 10 0 HZ LOG 20.0 10 11 0 7 4, ٠3 4

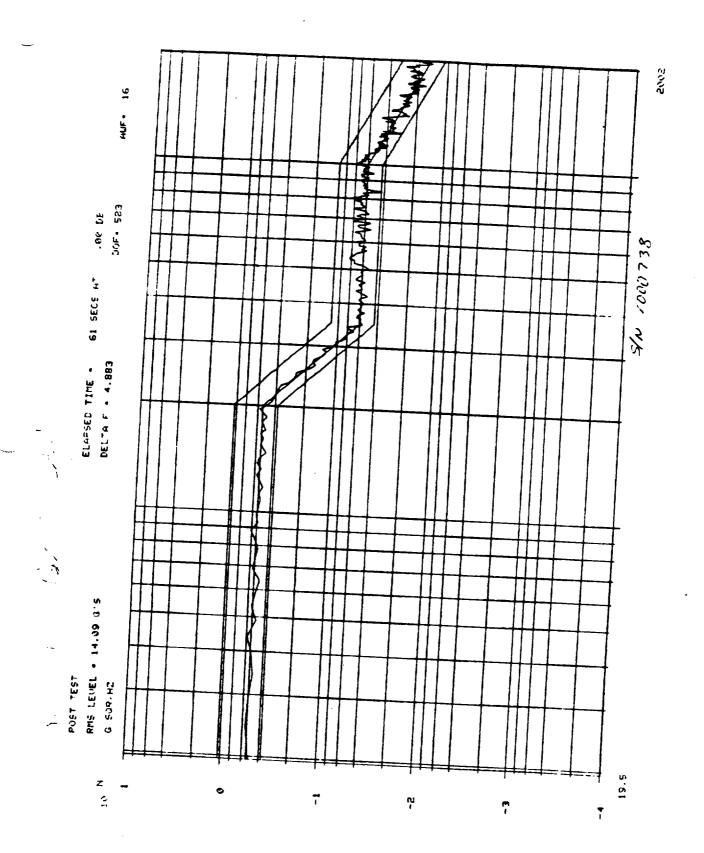


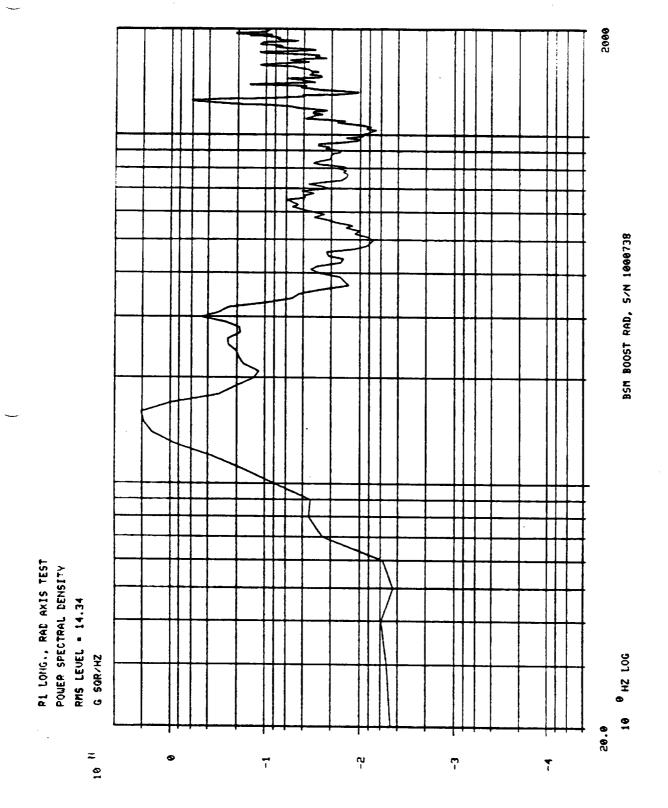


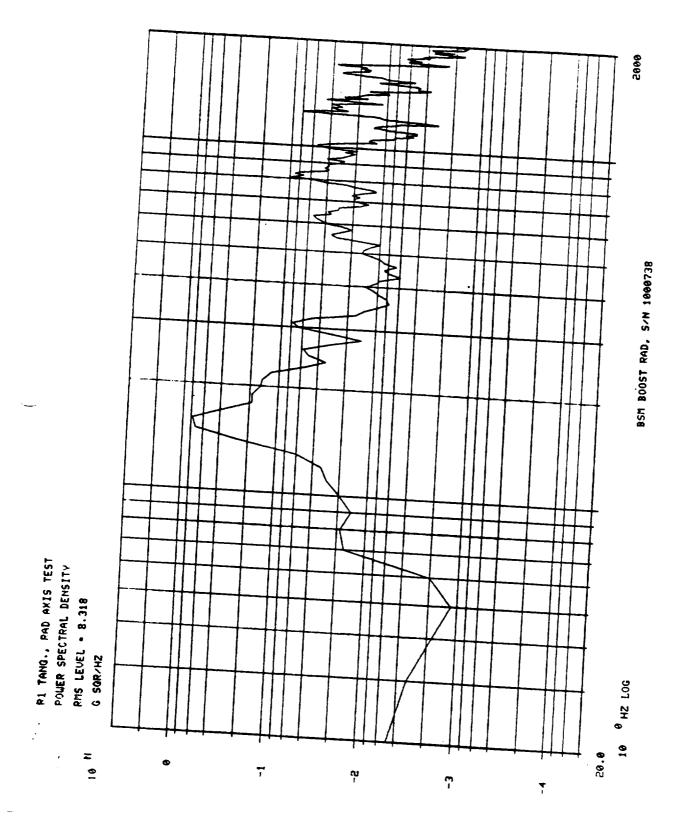


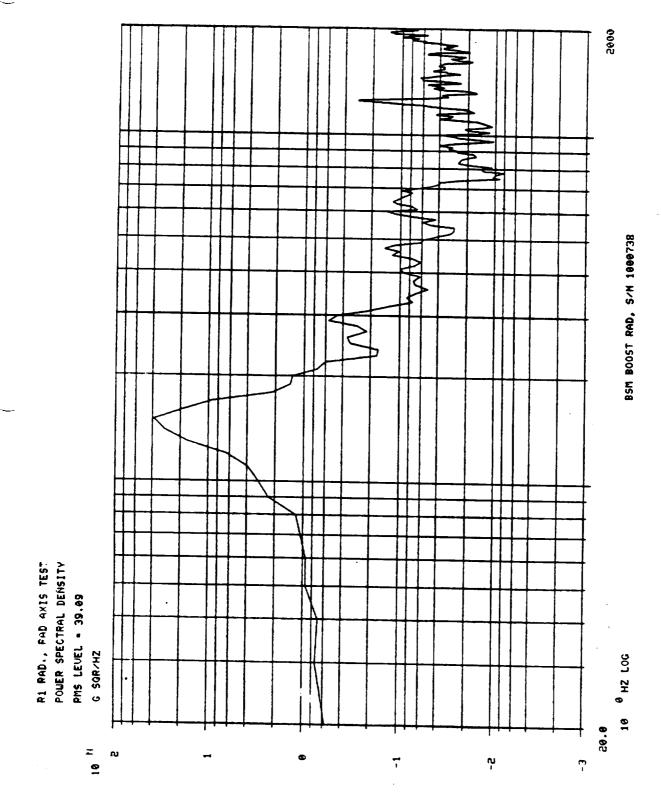
RADIAL AXIS
RANDOM, BOOST

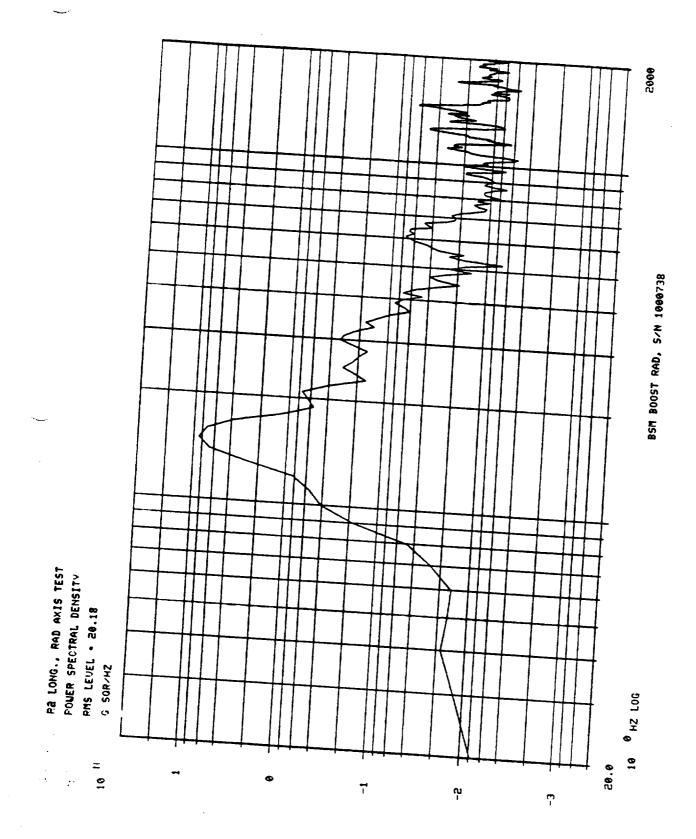


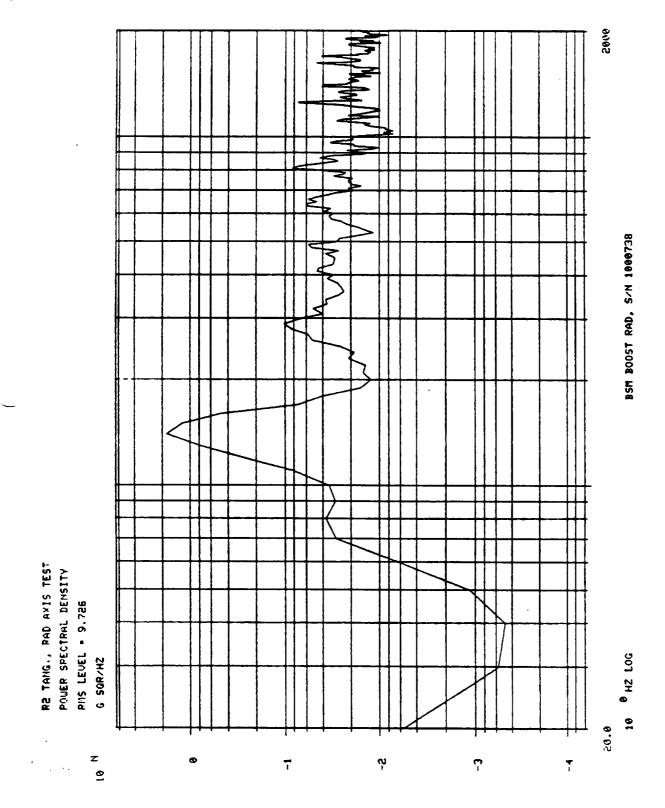


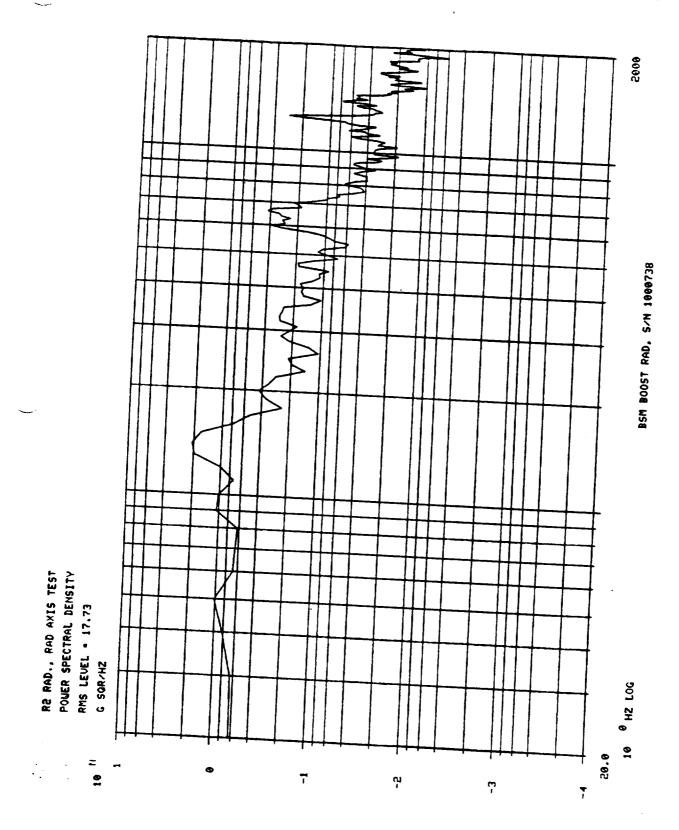




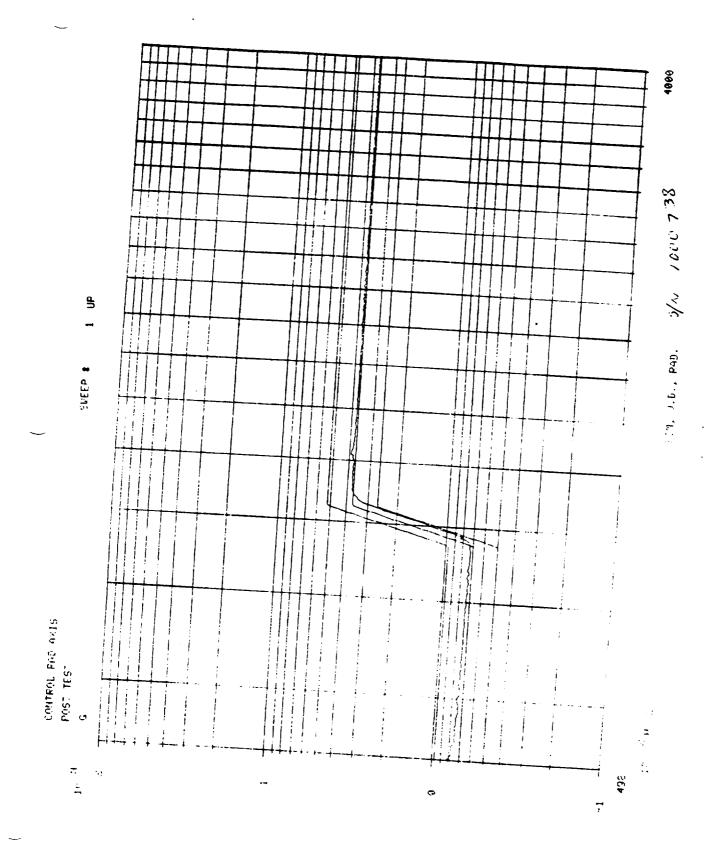


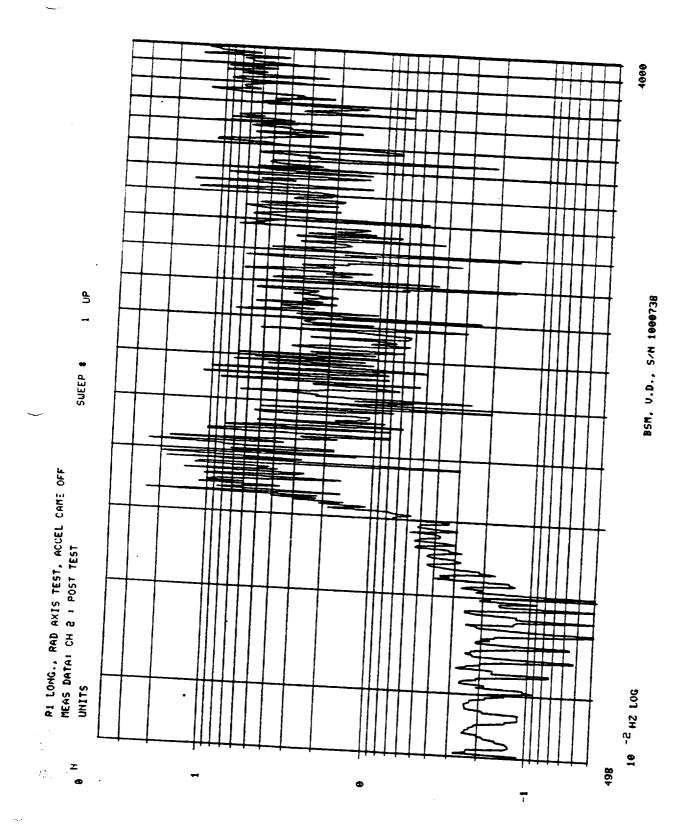


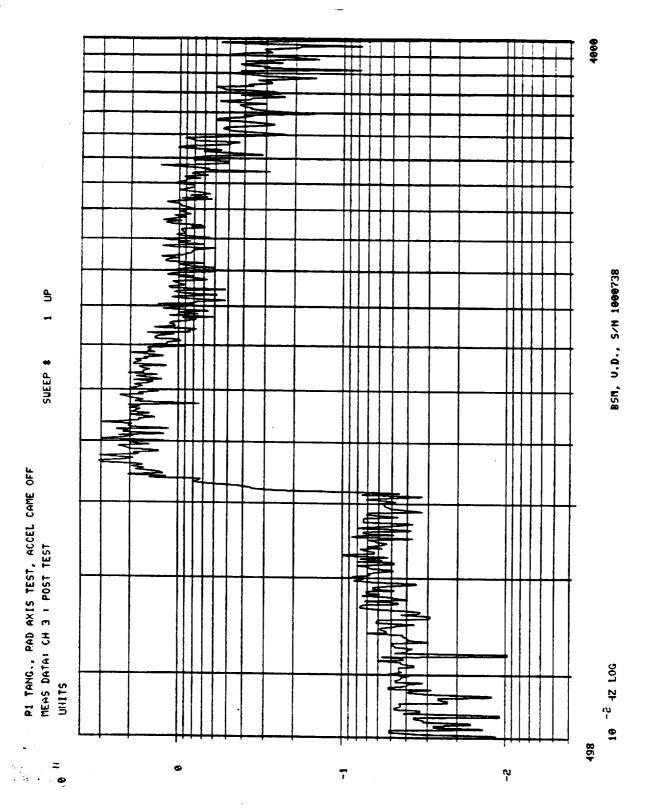


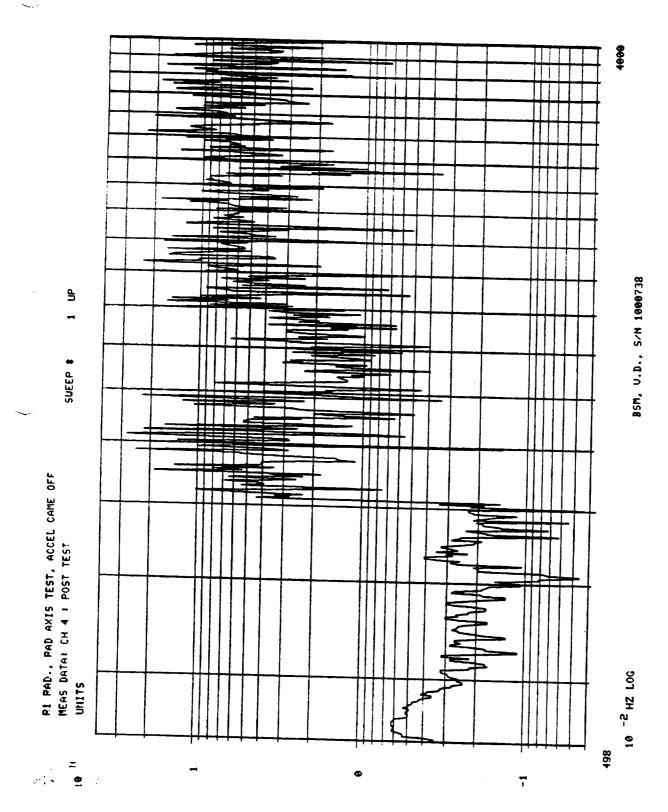


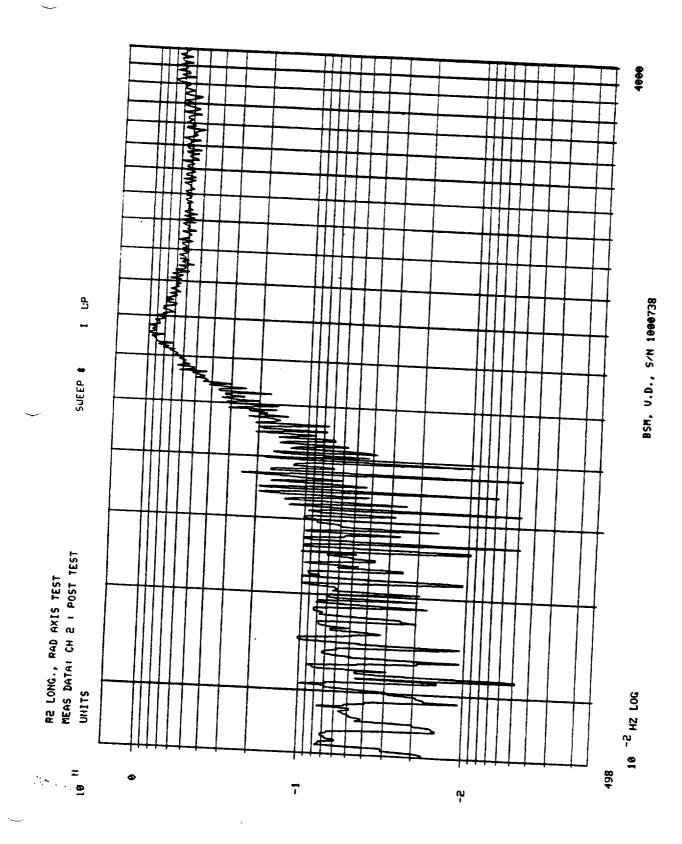
RADIAL AXIS
VEHICLE DYNAMICS

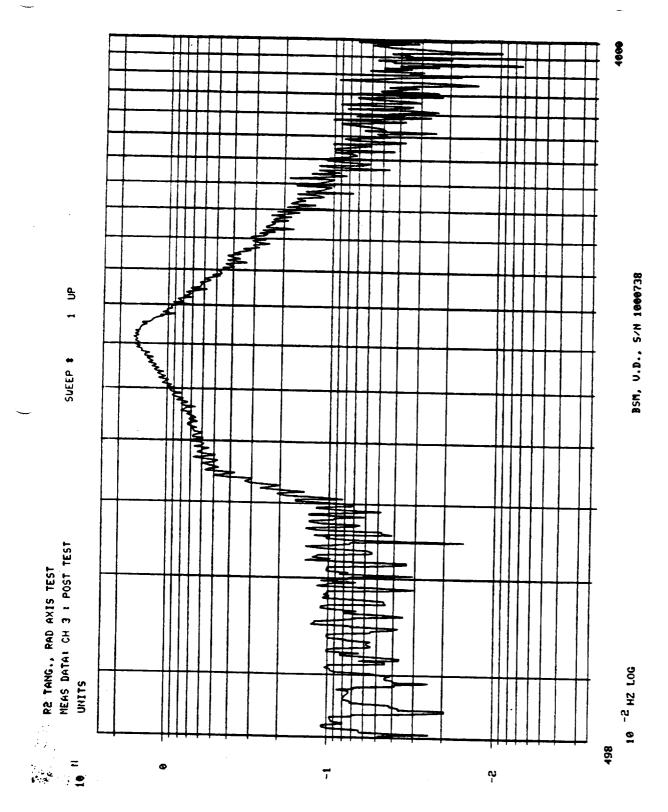


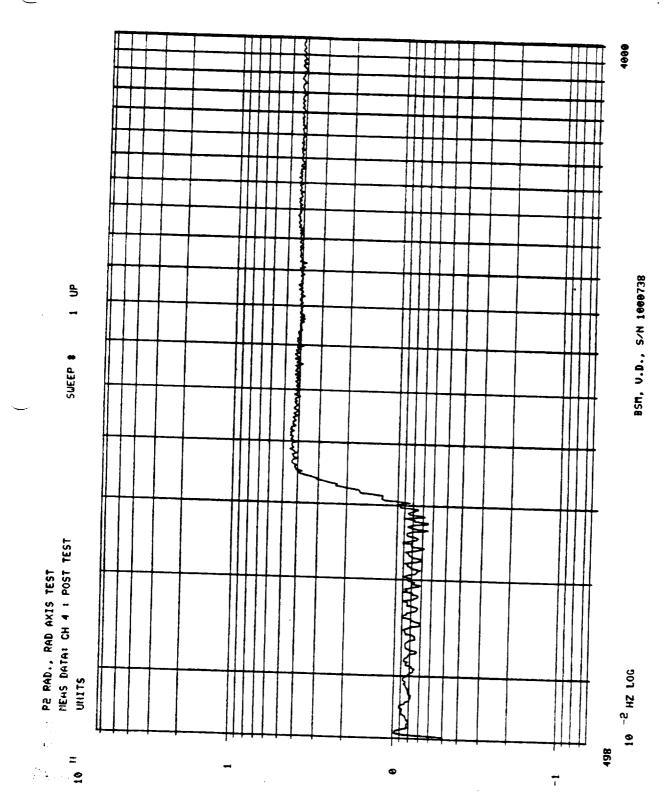




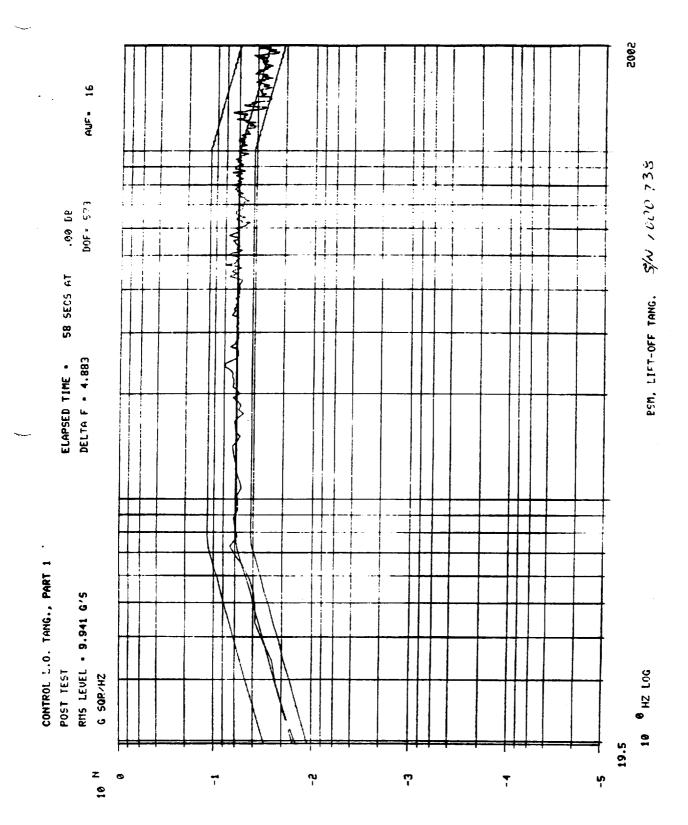


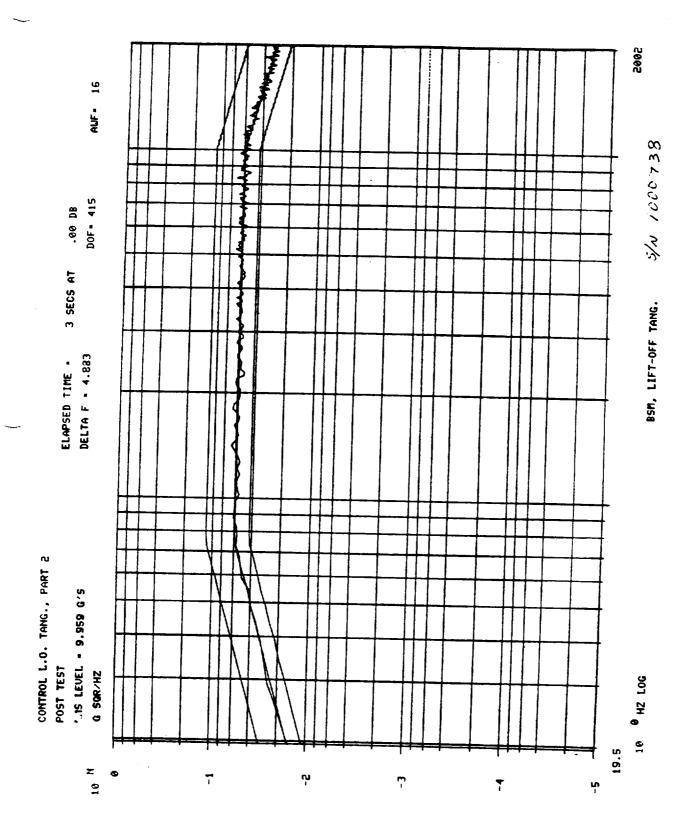


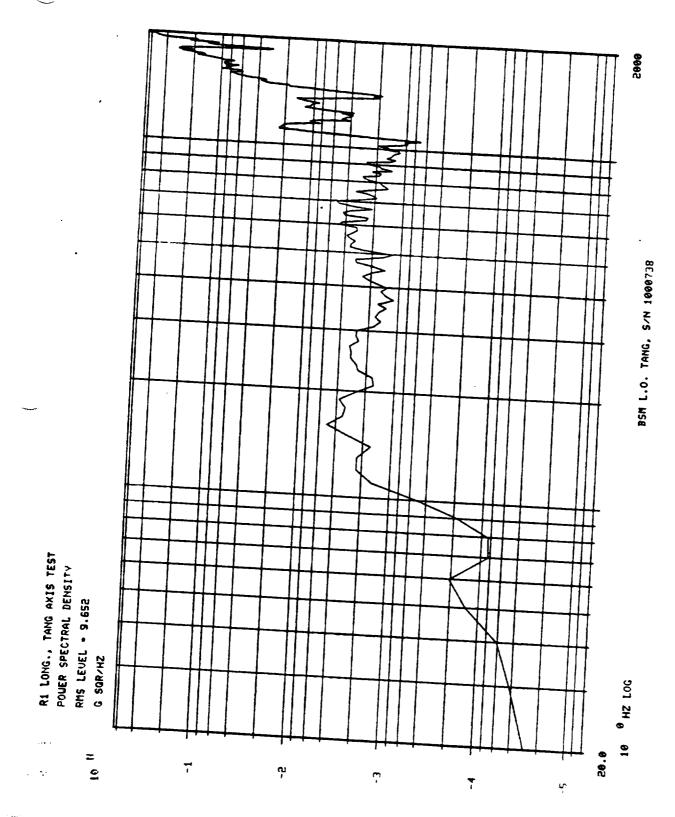




TANGENTIAL AXIS
RANDOM, LIFT-OFF



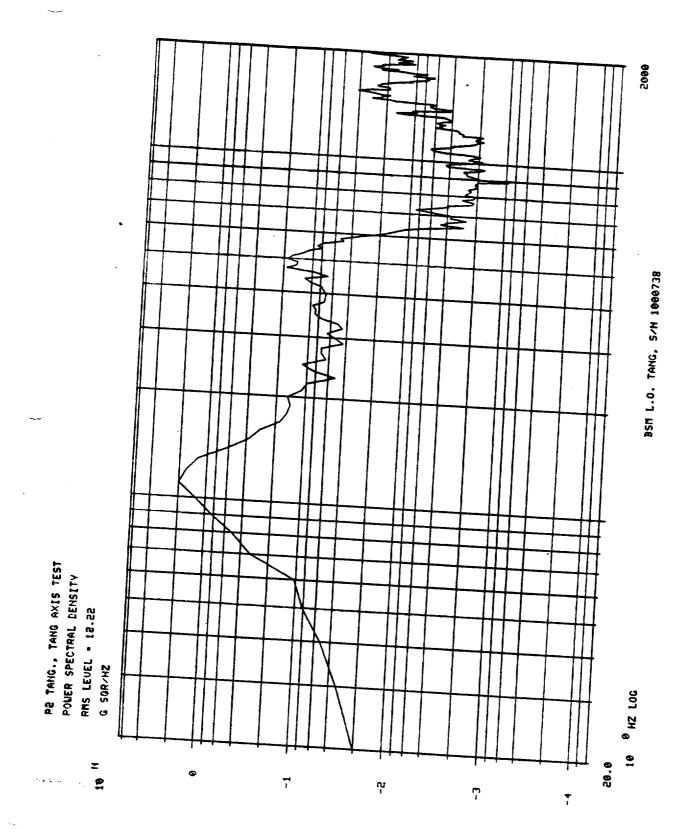


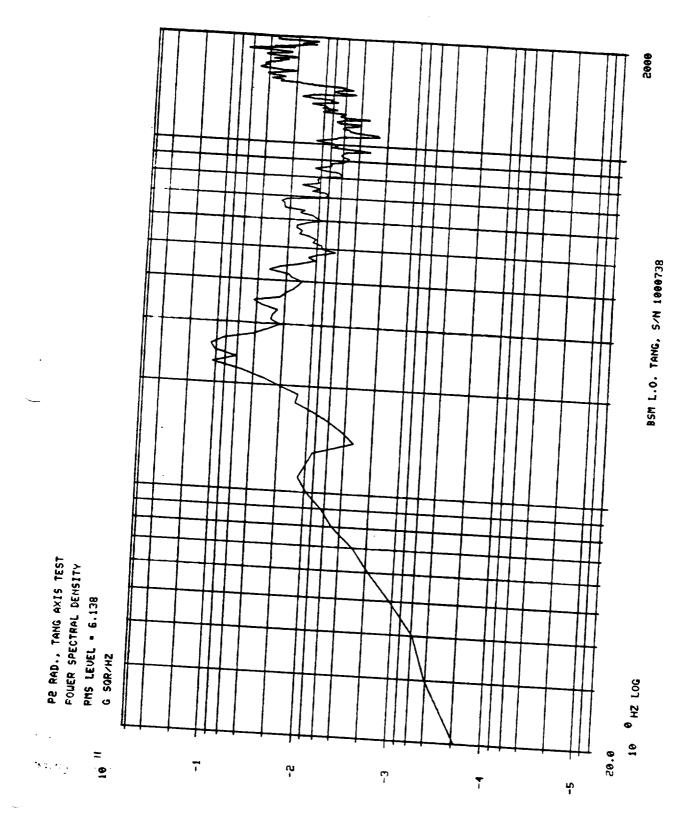


2000 BSM L.O. TANG, S/N 1000738 RI TANG., TANG AXIS TEST POUER SPECTRAL DENSITY PMS LEVEL - 13.76 G SOR/MZ 10 0 HZ LOG 20.0 0 ပု 7 Ç Ŧ

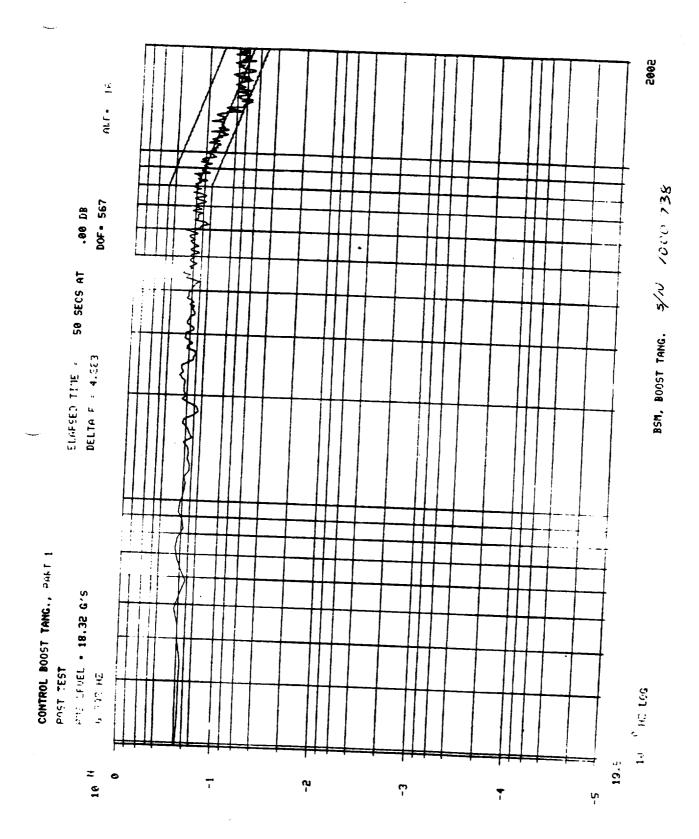
2000 BSM L.O. TANG, S/N 1000738 R1 RAD., TANG AXIS TEST Pouer Spectral Density RMS Level - 11.00 G SGR/HZ 10 0 HZ LOG 7 ហ ñ **T** . ņ

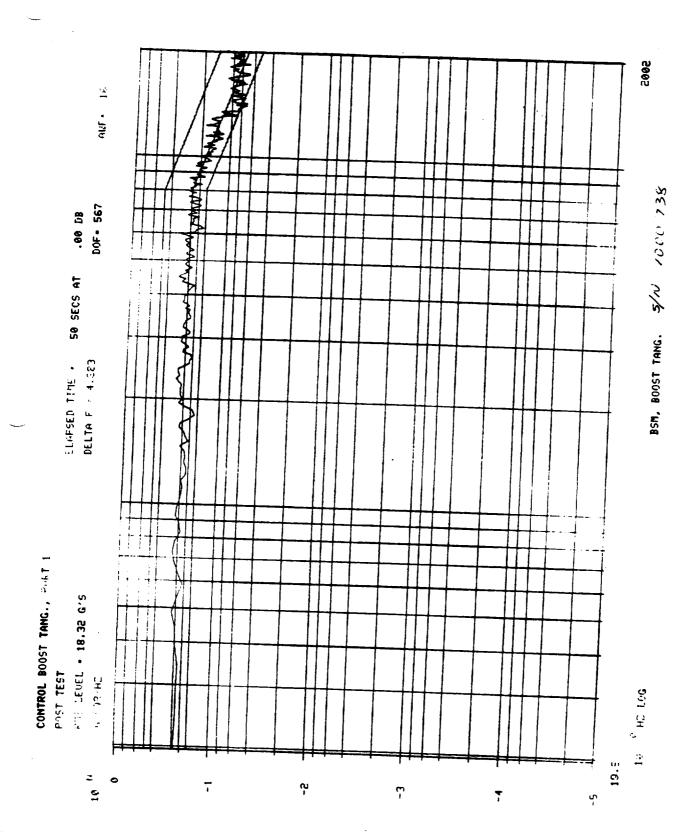
BSM L.O. TANG, S/N 1000738 PR LONG., TANG AXIS TEST FOLER SPECTPAL DENSITY PMS LEVEL = 3.542 G SOR/HZ 10 0 HZ LOG 7 ពុ ٣ Ŧ ş

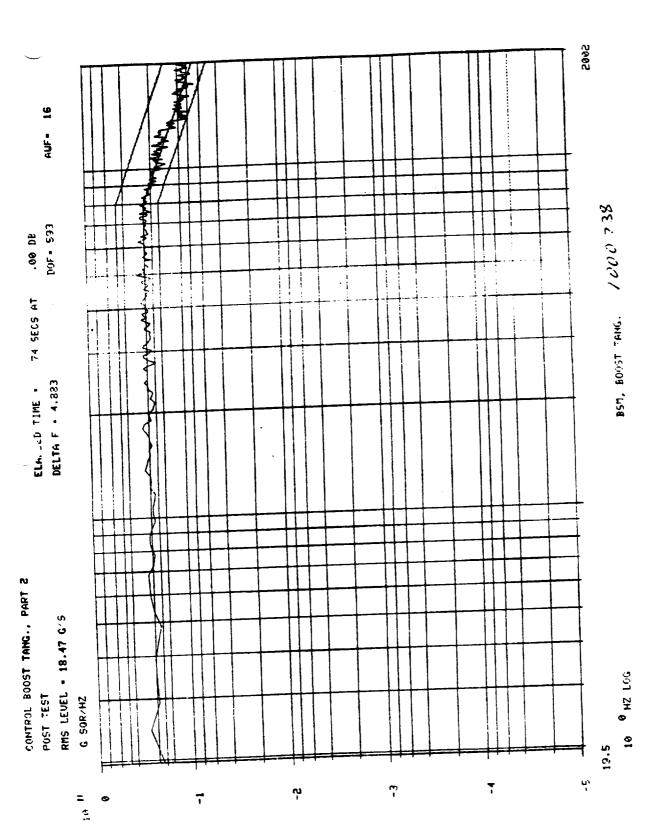




TANGENTIAL AXIS
RANDOM, BOOST





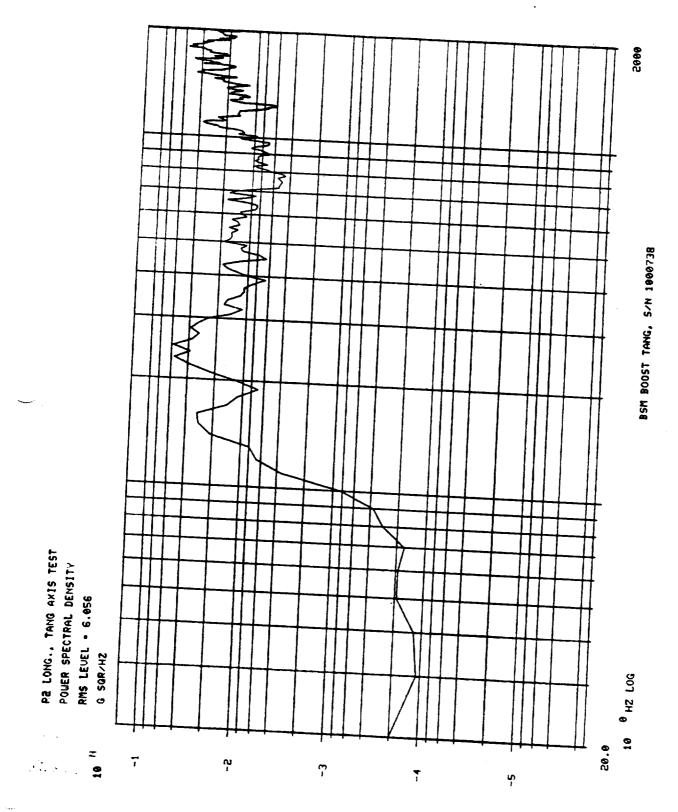


BSM BOOST TANG, S/N 1000738 RI LONG., TANG AXIS TEST FOWER SPECTRAL DENSITY RMS LEVEL - 16.55 G SGR/HZ 10 0 HZ LOG 20.0 Z 97 0 7 ដូ ٦ 4

BSM BOOST TANG, S/N 1000738 RI TANG., TANG AXIS TEST POUER SPECTRAL DENSITY RMS LEVEL - 25.04 G SQR/HZ 10 0 HZ LOG • 1 ည ņ

2000 BSM BOOST TANG, S/N 1000738 RI RAD., TANG AXIS TEST P'JER SPECTRAL DENSITY RMS LEUEL - 19.38 G SOR/HZ 30.0 0 7 ņ Ę-7

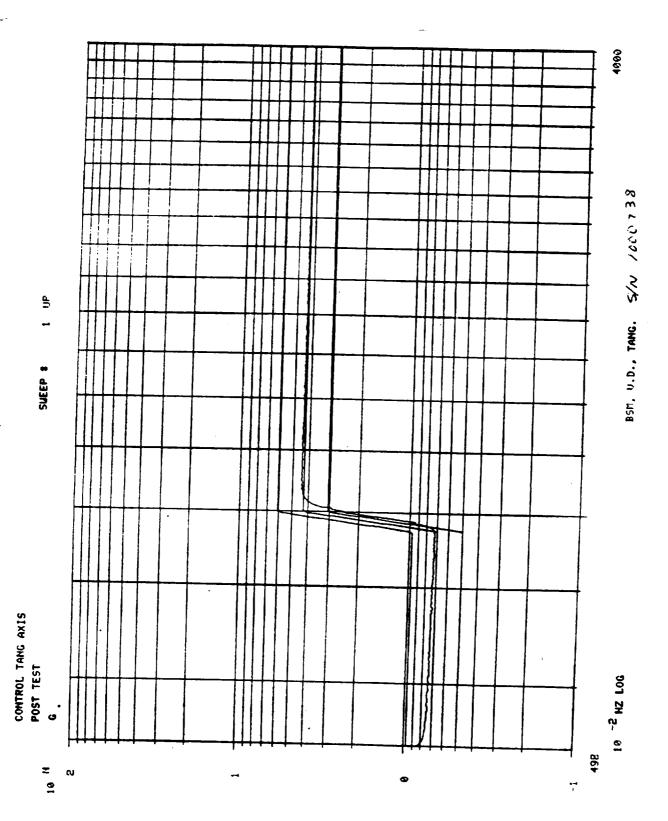
356

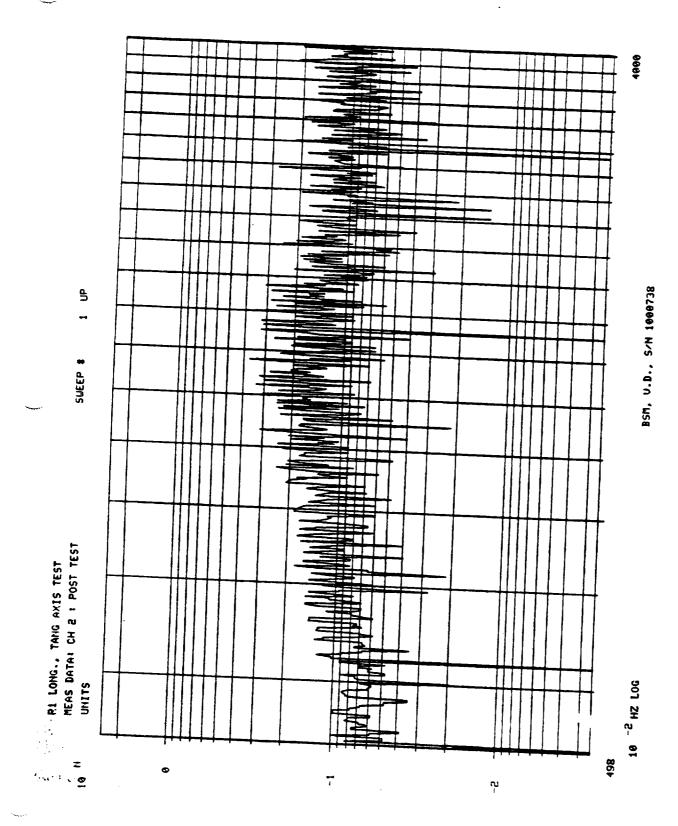


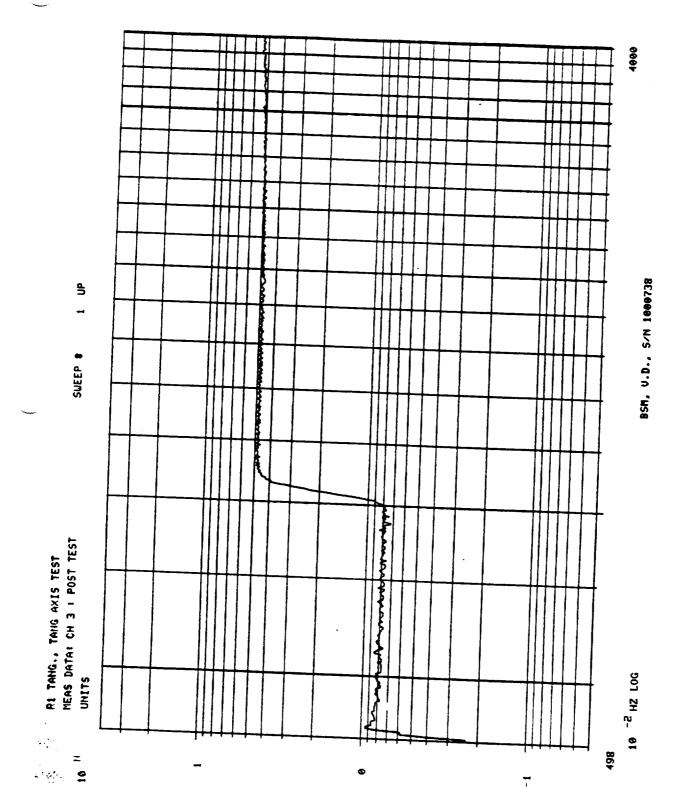
2000 BSH BOOST TANG, S/N 1000738 RE TANG., TANG AXIS TEST Power Spectral Density Rms Level - 24.79 G SOR/HZ 10 0 HZ LOG 20.0 • Ŧ ហុ -3

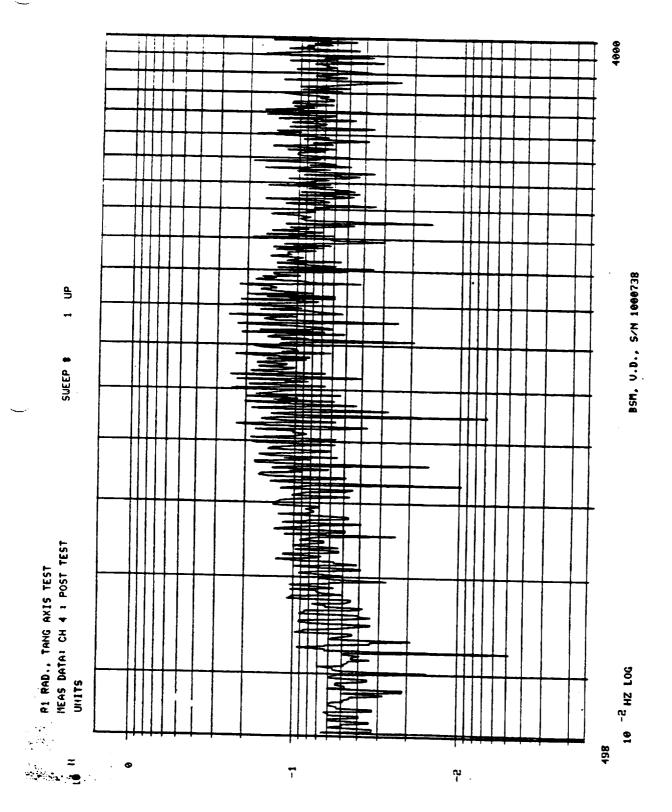
2000 BSM B005T TANG, 5/N 1000738 PE RAD., TANG AXIS TEST FOWER SPECTRAL DENSITY RMS LEVEL • 10.48 G SOR/HZ 10 0 HZ LOG 20.0 . : 7 ą 3 Ŧ

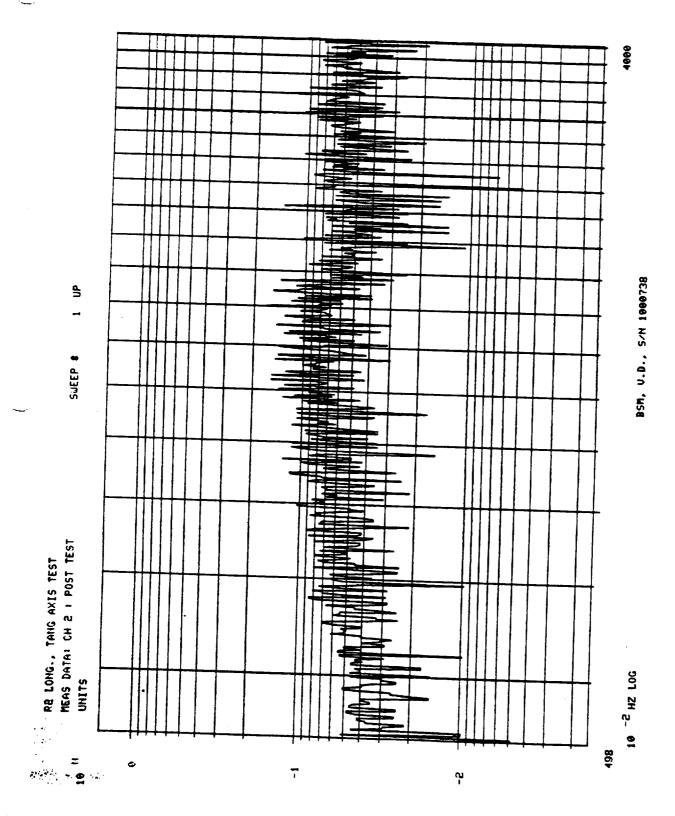
TANGENTIAL AXIS
VEHICLE DYNAMICS

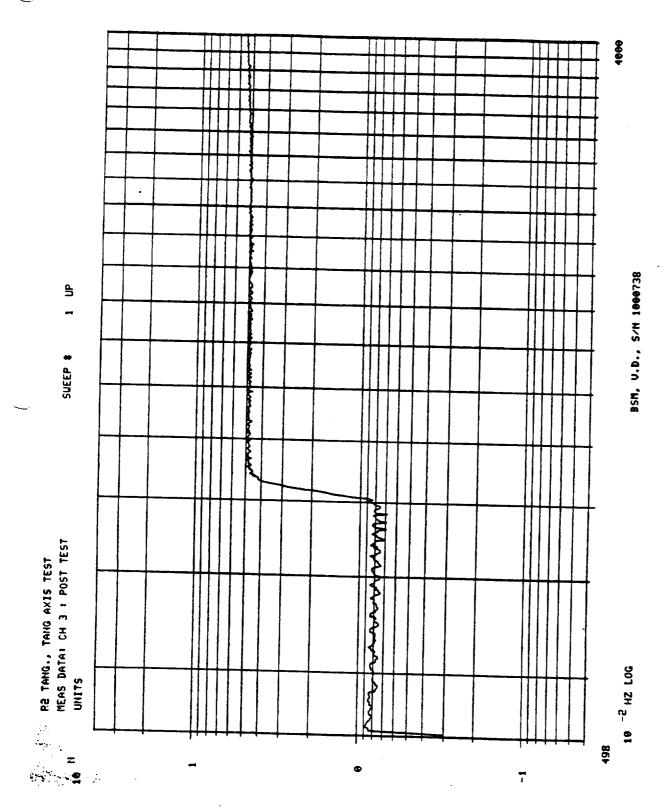


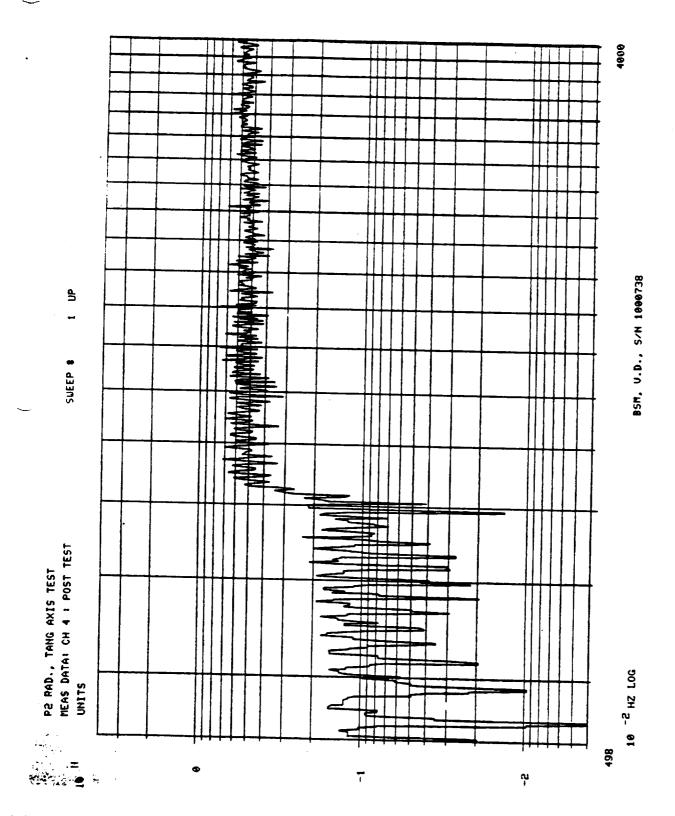




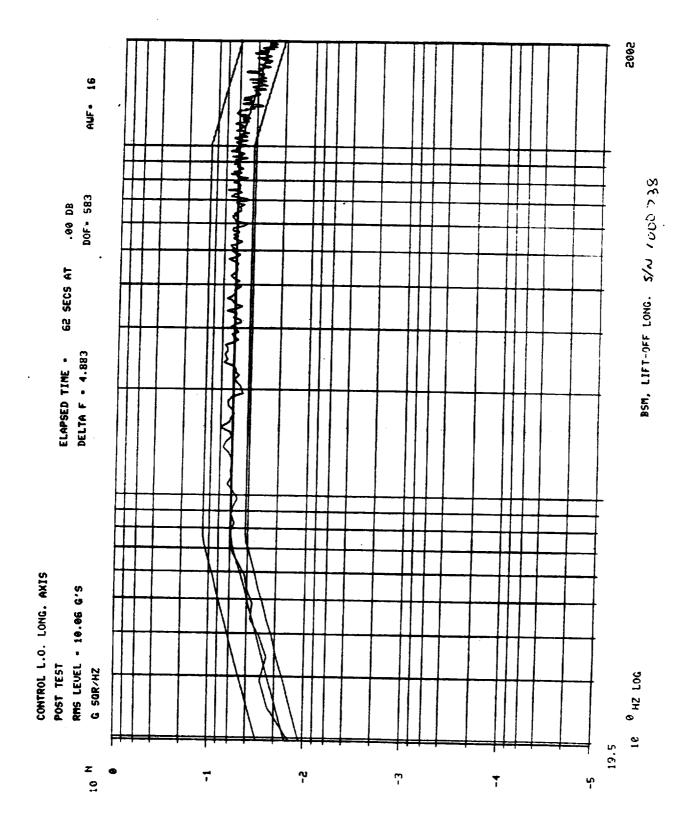


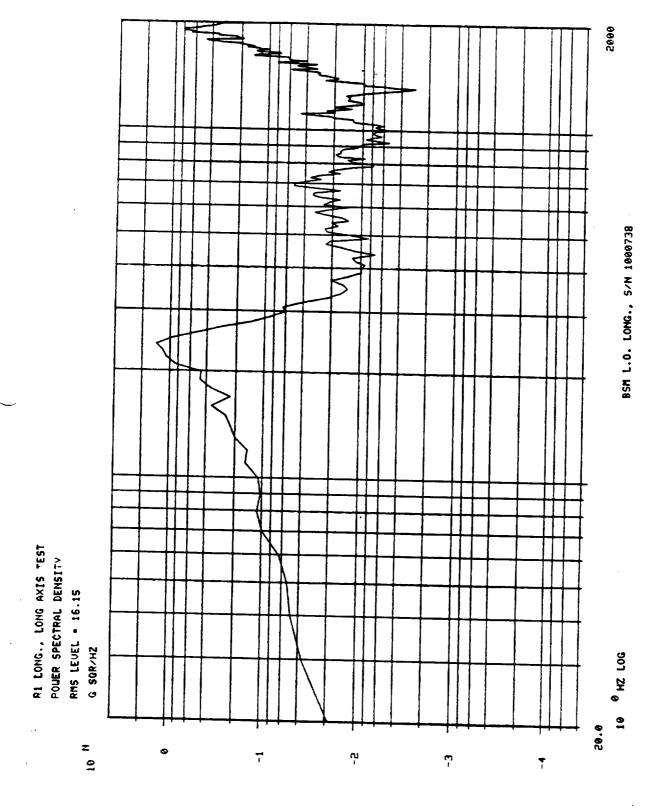


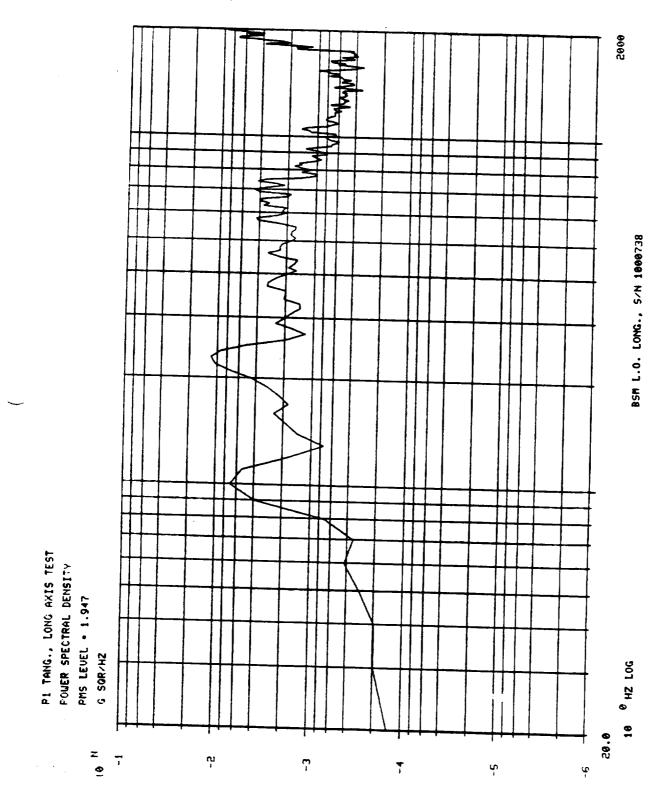




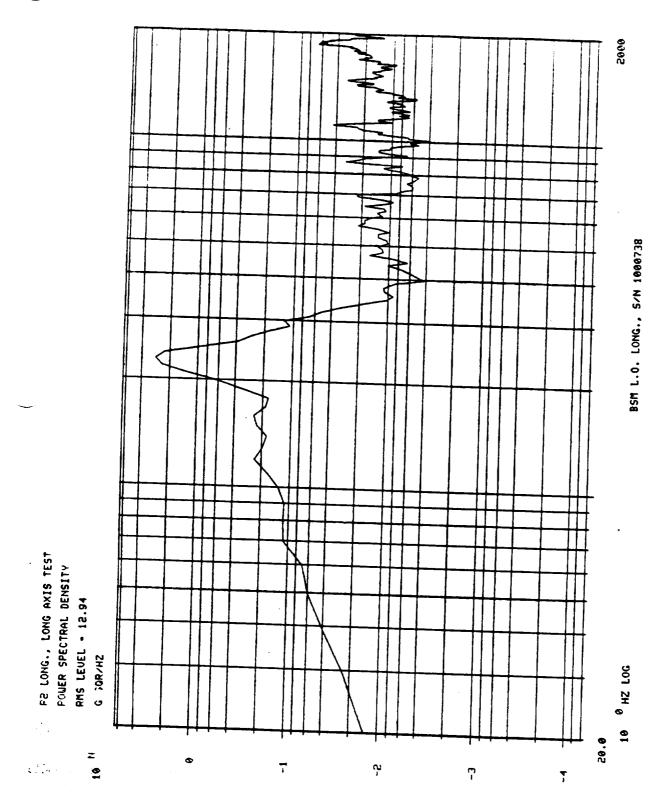
LONGITUDINAL AXIS
RANDOM, LIFT-OFF

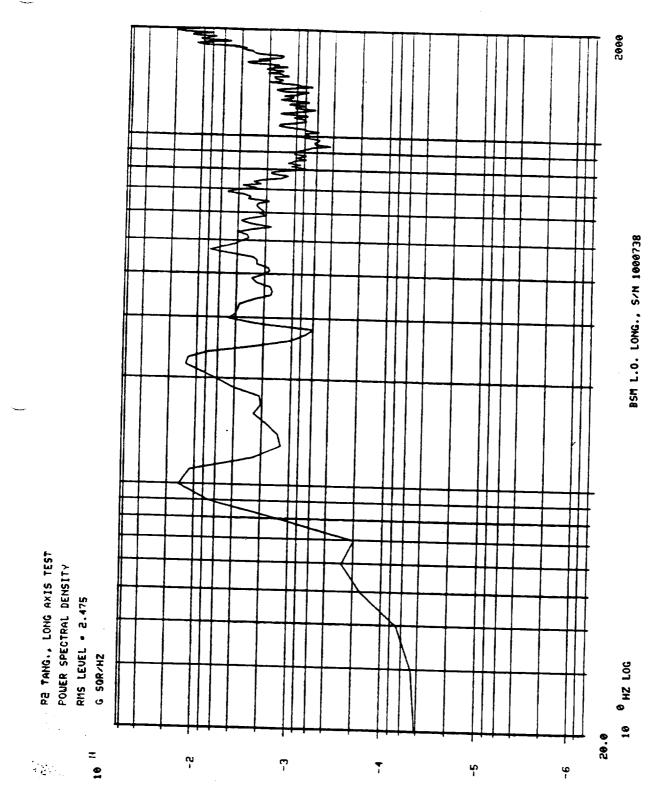


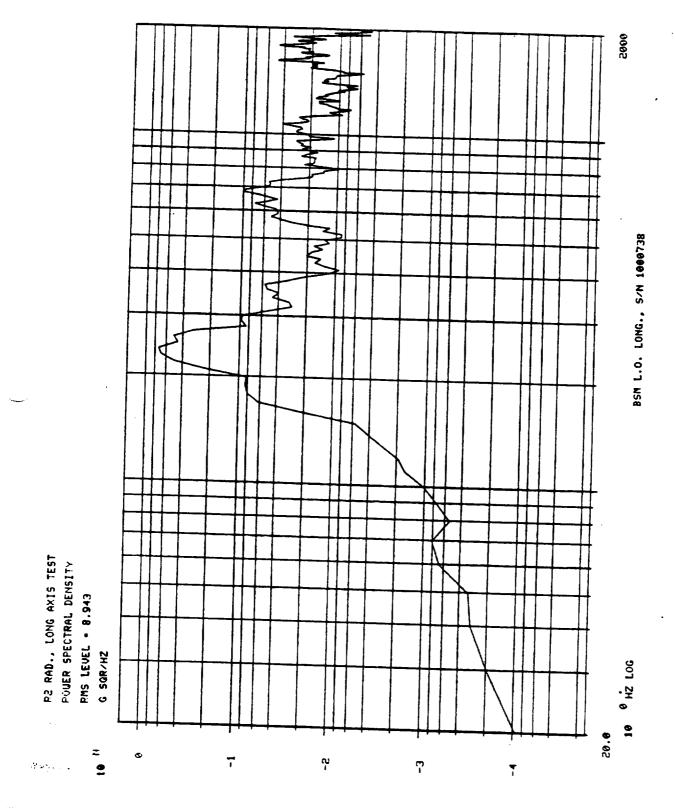




BSM L.O. LONG., S/N 1000738 P1 RAD., LONG AXIS TEST FOLLER SPECTRAL DENSITY PMS LEVEL • 12.71 18 ⁰ HZ LOG 11 01 7 <u>ا</u>ر



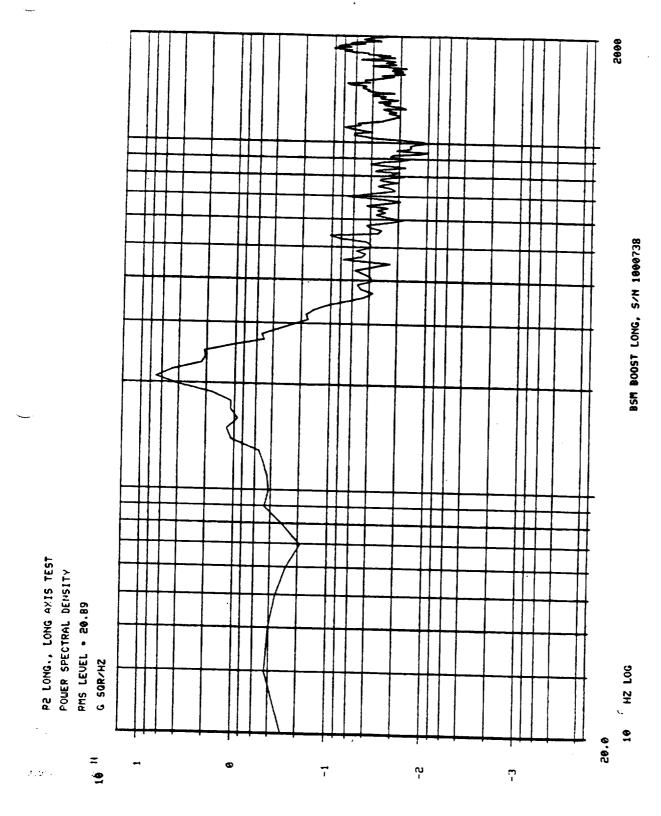




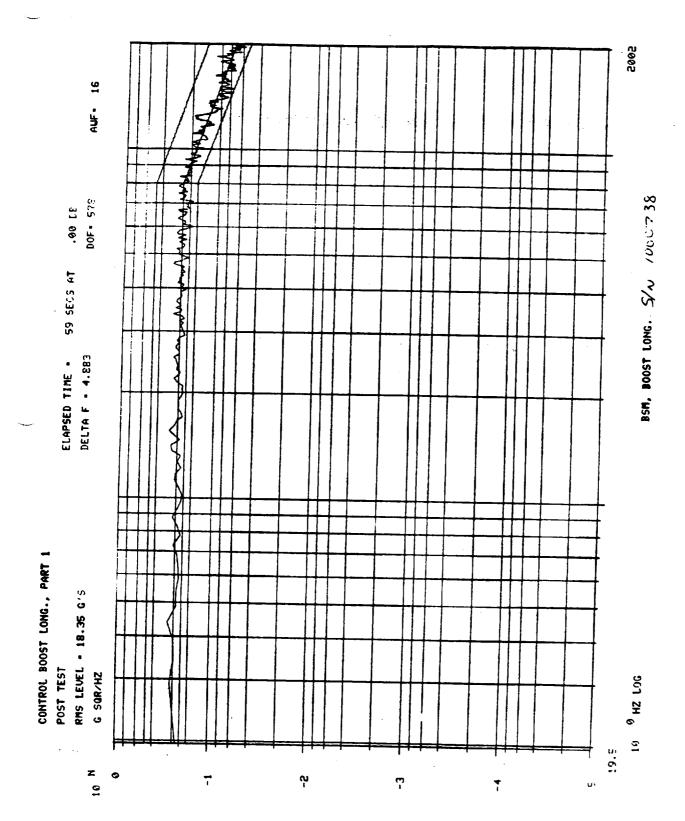
LONGITUDINAL AXIS
VEHICLE DYNAMICS

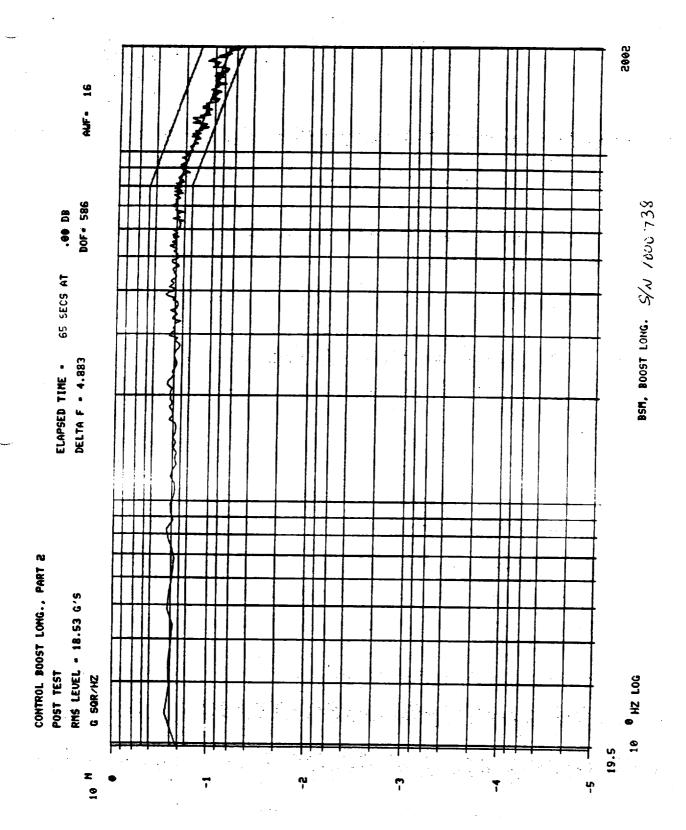
BSM BOOST LONG, 5/N 1000738 FR RAD., LONG AXIS TEST FOWER SPECTFAL DENSITY PMS LEVEL • 15.02 G SOR/HZ 10 0 HZ LOG 10 11

BSM BOOST LONG, S/N 1868738 RE TANG., LONG AXIS TEST POWER SPECTRAL DENSITY RMS LEVEL - 4.168 G SOR/HZ 10 0 HZ LOG 7 ď ۳ 7 ş

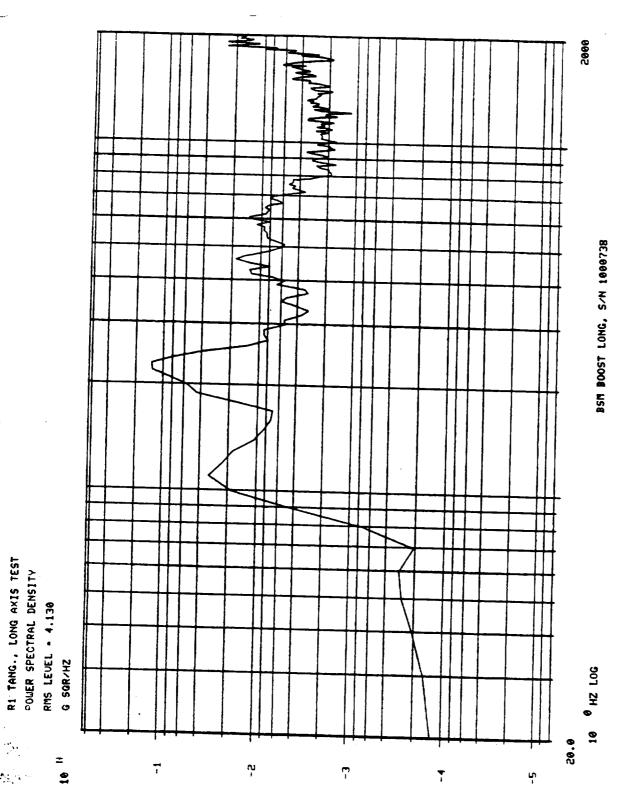


379



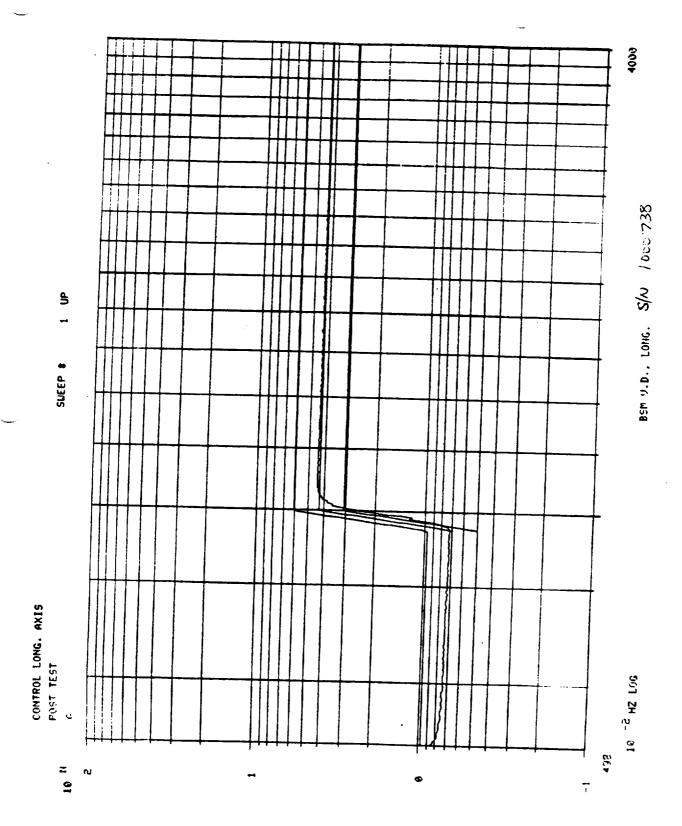


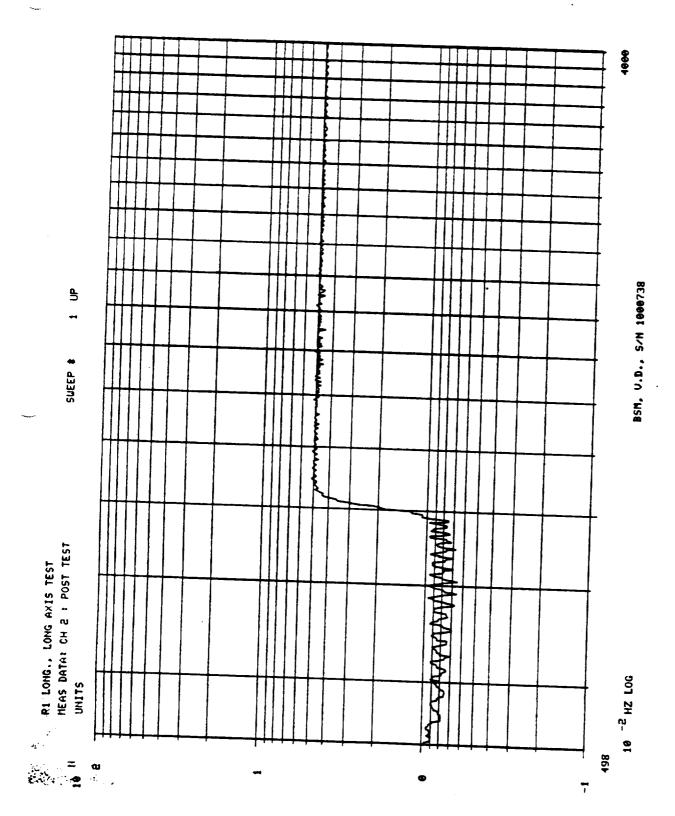
2000 BSM BOOST LONG, S/N 1000738 P1 LONG., LONG AXIS TEST POWER SPECTRAL DENSITY PMS LEUEL • 27.53 10 0 HZ LOG 20.0 ņ 7

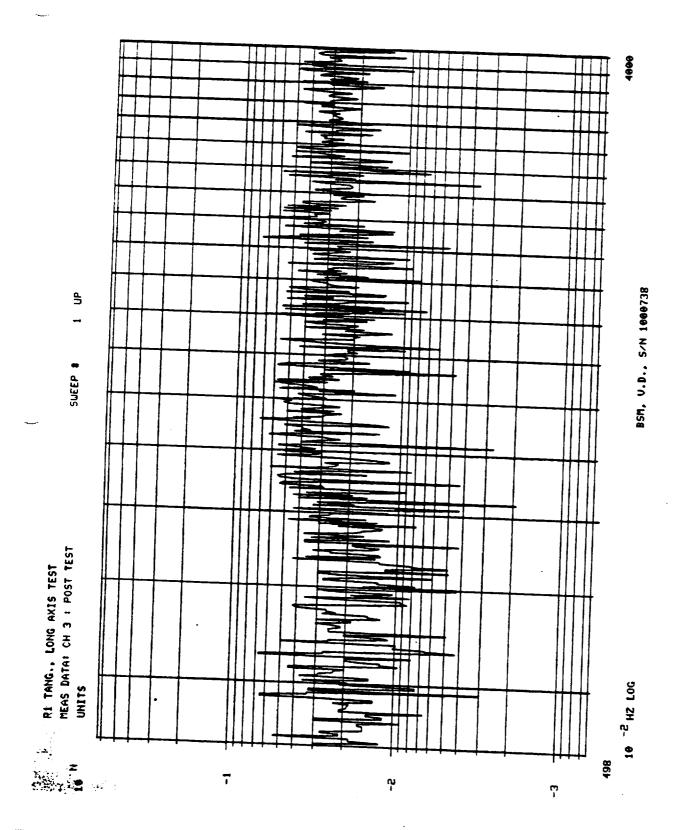


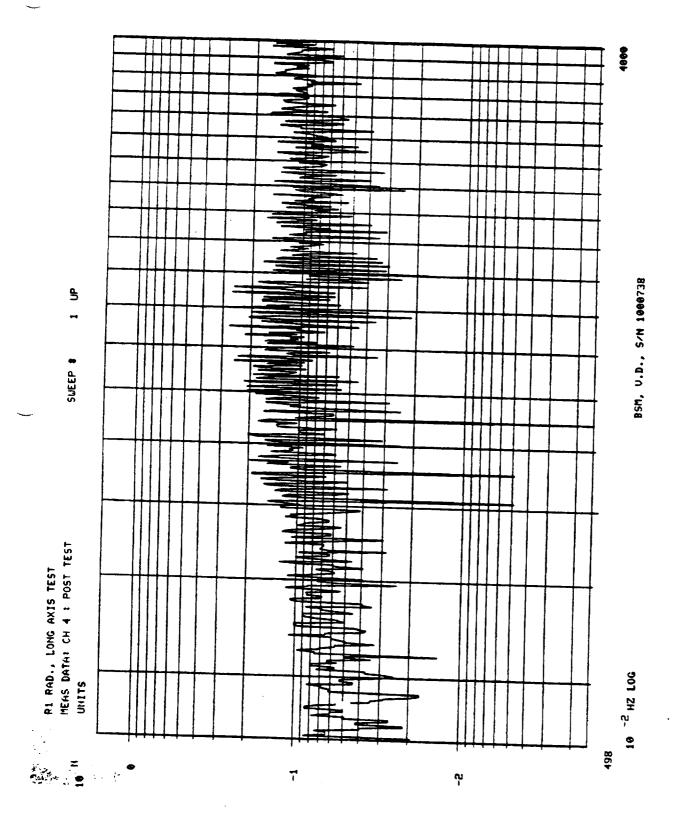
2000 BSM B005T LONG, 5/N 1000738 P1 PAD., LONG AXIS TEST POWER SPECTRAL DENSITY RMS LEVEL = 21.21 G SOR/HZ 9 HZ 100 80.0 -5 Ę, †

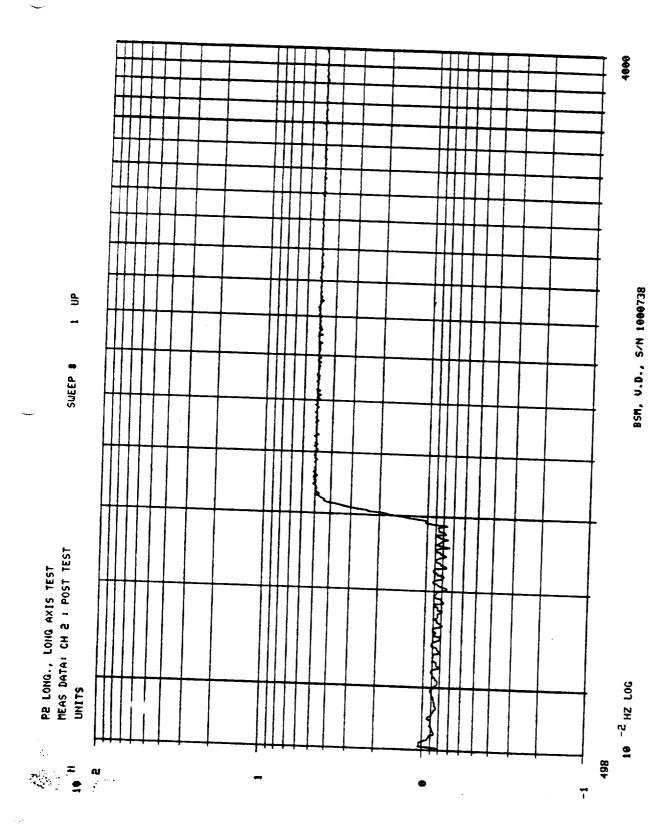
LONGITUDINAL AXIS
RANDOM, BOOST

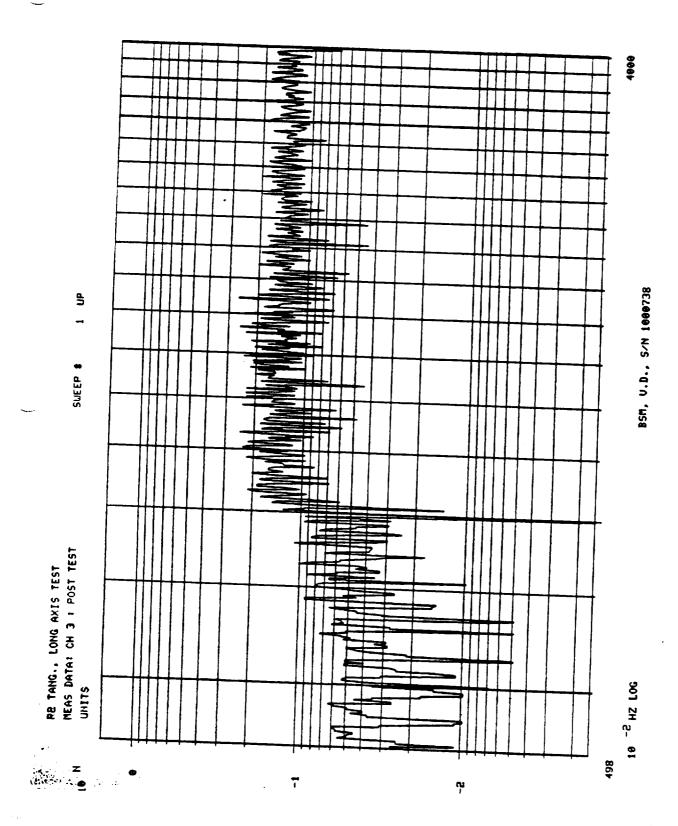


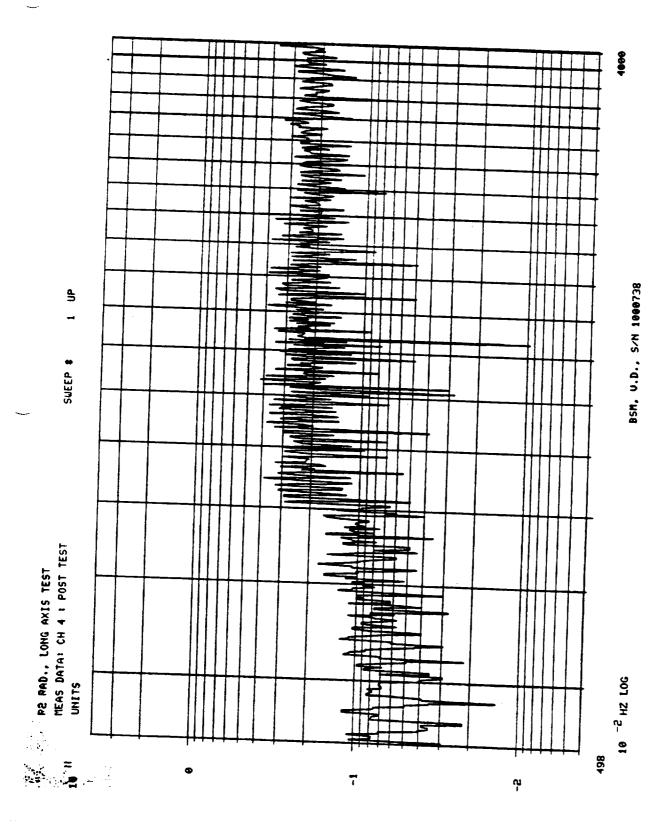












BSM MOTOR S/N 1000734 OBSERVATION AND DEVIATION SUMMARY

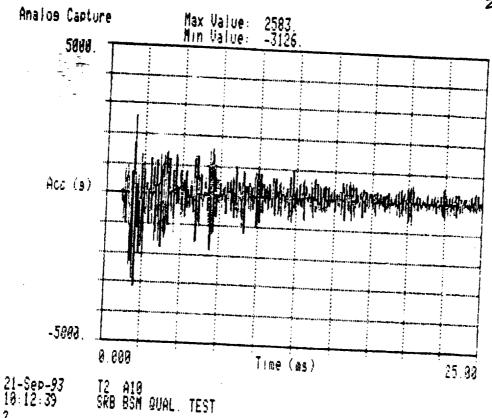
BSM Observation and Deviation Summary 1993 Delta Qualification Tests at MSFC

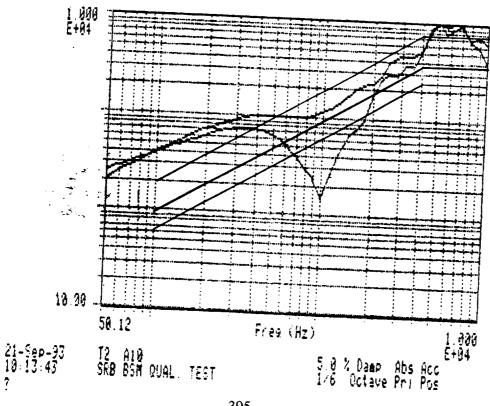
Motor SN: 1000734

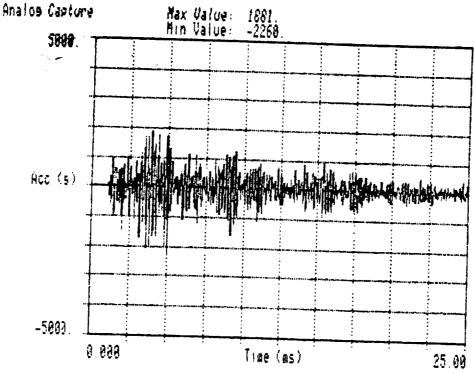
- #1. Reference step 6.2.1.8 in BSM-TCP-EP54-001. No damage was noted. Motor and container in good shape.
- #2. Reference step 6.2.6.4 in BSM-TCP-EP54-001. No propellant grain cracks or other defects noted. A small amount of RTV residue was observed on the igniter case and main propellant grain.
- #3. Reference step 6.4.5 in BSM-TCP-EP54-001. No damage was observed due to the pyro shock test.
- #4. Due to the loose fastener problem on SN 1000738, the forward bracket fasteners and the aero-heat shield fasteners were lockwired on SN 1000738. Torque stripes were also drawn on the bolt head so that any rotation during testing could be detected. Betts trequed to 160 coells.
- #5. Reference Test Procedure Deviation item 1 for BSM-TCP-EP54-003. Conditioning chamber temperature for this motor is 25° F, +0° F, -5°F. During the radial axis testing, the chamber temperature exceeded the 25° F upper limit. The maximum temperature reached 28.2° F. The total time the chamber was out of tolerance was approximately ten minutes. After the radial axis testing was complete, the chamber temperature resumed to within tolerances. USBI, CSD, and MSFC agreed that the motor could not respond to the small change in temperature in that short amount of time. Testing was resumed
- #6. Reference step 6.8.1 in BSM-TCP-EP54-003. No damage was observed to the BSM due to vibration testing. This inspection was performed before bracket removal. It was noticed during this inspection that three of the forward bracket fasteners had de-torqued slightly (recall these were lockwired). The aeroheat shield fasteners remained torqued.
- #7. Reference step 7.3.4 in BSM-TCP-EP54-003. No cracks or other internal defects noted on the propellant grain.
- #8. Reference step 7.5.5 in BSM-TCP-EP54-003. Light burnishing marks were observed on the forward face of the BSM.

Mat Bevill

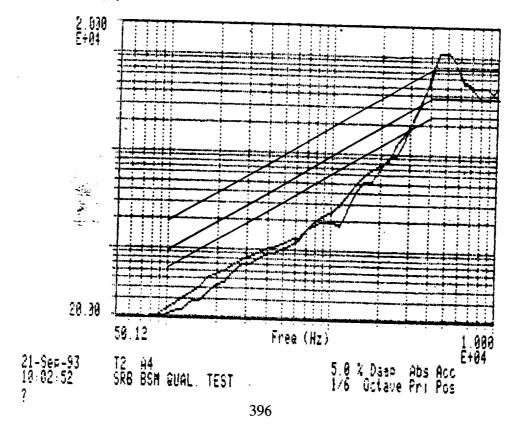
		rigure 1	
		TEST PROCEDURE DEVIATION	TCP NO.
TEST ENGINEE	A:	QUALITY:	BSM-TCP-EP54-001
Mat B	·	MB 09/24/93 Rick Clements no a se	9-93 09/29/93
	_		
TYLE:		Kichard Leonard (safety)	Ruf 9-29-93 SHEET / OF 7
OEV. PAGE	er Lim	it Tolerance Violation for Pyro Shock Si	imulation Test (SN: 1000 734)
NO. PAGE	20	CHANGE/REASON	PER
		Section 4.2.1 in BSM-TCP-EPS4. test tolerances for shock Responses + 6 dB and - 3 dB when analogetare shock spectrum analogetare shock spectrum analogetary. The worst case overtest for early the attached graphs. X-axis: accelerance ten #10 Y-axis: accelerance ten #10	lyzed with a 13 lyzer and 5% lich axis is shown
		Z-axis: acceleraneters #1. Motor SN: 1000734	2 and #9
		Jim Herring J.B. Hirring Engineer	
			-
GINATOR:	+ Bevi	-1/	ORGANIZATION:
11111.7	DOVI	N.Y	
IVE DEVIATION	N(S) INCH	ASE HAZARD LEVEL: SAFETY 394 Policy of the safety of the	NASA MSFC EPIZ

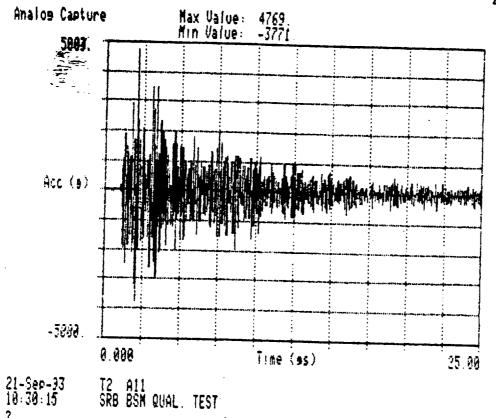


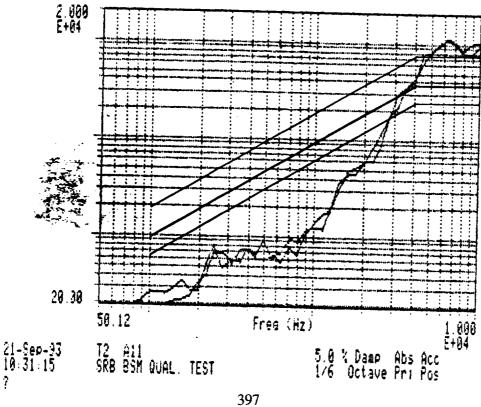


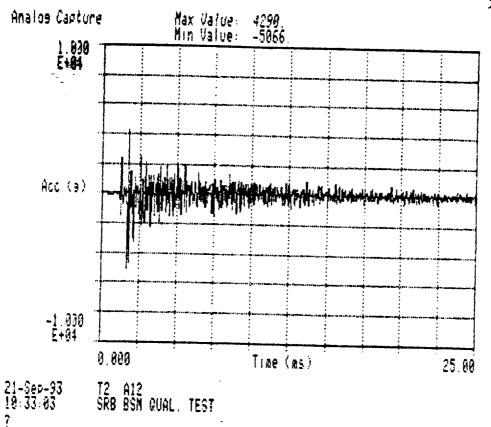


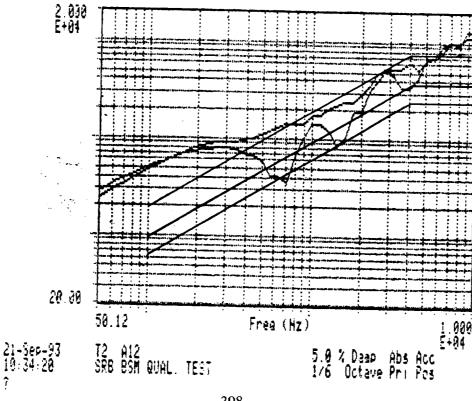
21-Sep-93 T2 A4 18:01:51 SRB BSM QUAL, TEST

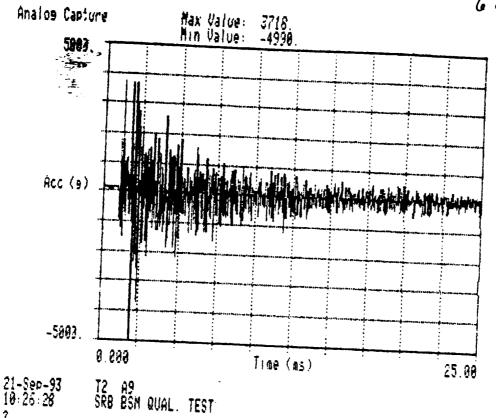


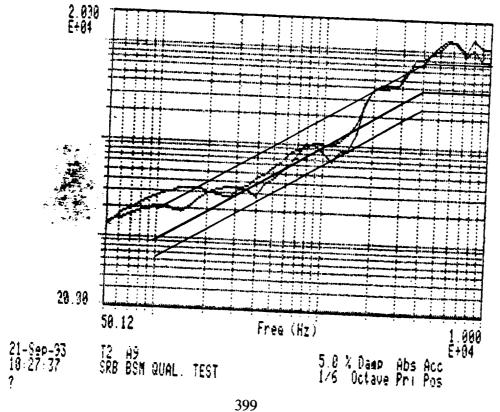












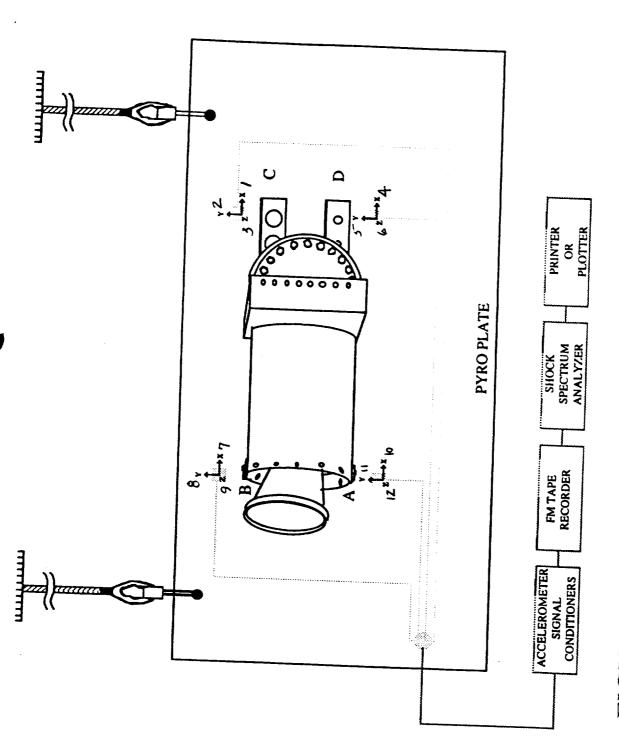


FIGURE 1. PYRO SHOCK CONTROL EQUIPTMENT

			TEST PROCEDURE DEVIATION	TCP NO	
EST ENGINEER: DUALITY. DATE		-003			
		Bevill	MS 09/24/93 Rick Clements pc 9-29-93	· · · •	
QUIA	EMENTS	ENGINE	OTHER:		
TLE:		1	Richard Leonard (Safety) Rys 9-29	93 SHEET / OF Z	>
EV.	MGE	SEQ.	Violation for Radial Axis Test (SN:	1000734)	
		24	CHANGE/REASON		PER
			Section 8.0 in BSM-TCP-EPS4-002 conditioning chamber temperatures for qualification motors. The "cold" motor conditioned at 25°F +0°F. At 11:38:42 am. on 89/25/93 the conditioning exceeded its 25°F upper limit. The chamber of temp. for 8 min, then out again a 12:04:42 for ~2 min. respectively. The occured DURING the radial 9+15 vibrous USBI, CSD, and MSFC all arread that 1 not respond in the short amount of time of temperature.	the delta ris to be g chamber temperature amber was out t 11.58:42 and ese violetions ration test.	
			SN: 100073	4	
			Max temp. during testing was 28.2°F,		
INATO	DA:		.•		
_	Min	1 B		IZATION:	L
			401 N4	A MSFC EP/2	

CAUTION: When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.

After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may continue.

If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety, and evacuate all personnel to safe locations as directed by safety.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

6.2.1.8	Slowly, monitoring static charge, lift the motor out of the container using the overhead crane. Lower the test item so that the forward end of the motor is at waist height.	M
	A detailed visual inspection shall be performed by the MSFC test engineer and the CSD test engineer on the live test items before testing. Record the motor's serial number.	
	No Damage No Jamage MS Damage (detail in attachment)	
	Serial Number	
CAU	JTION: The following step involves working with a suspended	

owing step involves working with a suspended load. Keep hands and feet out from under the load.

Attach the "break-over" brackets and lifting strap on 6.2.1.9 the forward end of the motor (see Figure 2, Appendix C).

IH

CAUTION: Do Not disconnect the ground wire while breaking the motor to the horizontal position.

		Record SN of torque wrench: C'EMJ 6035 9 A, B, D B1	W-ZRCE
	6.2.5.2	Release the tension from the lifting straps but do not disconnect the straps. These straps may be used to tape off accelerometer wires if necessary.	14
	6.2.5.3	Place the pyrotechnic debris shield in front of the large bay doors on the north side of the pyro room.	[4]
	6.2.6	Perform Grain Inspection	
	6.2.6.1	Clear area of all nonessential personnel for grain inspection. (Only the grain inspectors (2) and the MSFC TE shall remain.)	κJ
	6.2.6.2	Verify grain inspector(s) is(are):	Ŋ
		a. Wearing 100% cotton coveralls, shorts, and undershirts.	-
		b. Wearing a wrist strap.	
		c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.	•
	6.2.6.3	The grain inspector shall now remove the security bag and cover from the exit cone.	B
	6.2.6.4	Perform grain inspection.	
		Cracked propellant? yes	
	(If yes, give approximate location and size of crack. The	
		noted. Small amount of RTV4 residue on land	<u> </u>
mB	$\int_{\mathbb{R}^{n}} \int_{\mathbb{R}^{n}} \int_{$	Case and main grain. OK to proceed with pyroship Test. Other comments on grain condition:	rck
1163	$\overline{}$	Z	
ألجال	\rightarrow		
		Grain inspector S. Blantons 9-21-93	9-21-93
	6.2.7 <u>Ins</u>	stall Aero Heat Shield	

CAUTION: When using trichloroethane, personnel shall wear chemical goggles and Neoprene-Latex gloves.

Contaminated materials shall be disposed of as hazardous waste.

4 21-93

	,	
6.	3.7 On the count of "3", the pyro technician shall put the switch in the "ARMED" position and verify that the power indicator is illuminated.	N
6.3	3.8 On the FIRE command, the pyro technician will open the red cover and flip the firing switch.	M
6.3	3.9 After firing, turn the firing panel key to the "UNARMED" position.	[y]
	WARNING: If blasting cap does not fire, refer to Section 10.4 in ED73-SHK-FOP-004 (see Appendix A).	
	Blasting Cap Fired: yes no	
6.3.		
6.3.	11 Test personnel may now return to the control room.	M
6.3.	Wait a minimum of 5 minutes of a second second	[Y
C O :		M
6.3.1	reduce the data.	IM
6.4	Post Test Inspection	
6.4.1	Inform the MSFC TF that the door to room 170 from the control room is to be opened.	M
6.4.2	The pyro technician shall enter room 170 and move the junction box switch to the "BULB" position.	[Y
6.4.3	Remove blasting cap leads from junction box.	/
6.4.4		M
	WARNING: If all explosive items did not fire, refer to Section 10.5 in ED73-SHK-FOP-004 (see Appendix A)	
6.4.5	the pyro shock test. Any anomalies will be recorded. All other personnel shall remain in the control room or in the clear area until the "ALL CLEAR" is given by the MODE.	. [14]
6.4.6	MSFC TE indicates all clear for appropriate personnel.	
6.5	Post Test Removal from the Pyro Plate	(Y

2153,1

6.7.3 Vehicle Dynamics

6.7.3.1 The following levels and conditions apply for the vehicle dynamics test. Vibrate the motor only as follows.

V

Frequency (Hz)	Level
5 to 10	0.7 g peak
10 to 40	4.3 g peak

Sweep Rate: 3 octaves per minute

6.8 Post Test Inspection

	The BSM test item shall be visually inspected by the MSFC QA, MSFC TE, and the CSD TE for exterior damage resulting from vibration testing.	[W]
6.8.2	Remove all instrumentation.	
		M

6.9 Data Requirements

Power Spectral Density (PSD) plots for all control and response accelerometers for lift off and boost tests shall be recorded. The test tolerances shall be overplotted on the control accelerometers plots. Acceleration versus frequency plots shall be recorded for all accelerometers used during vehicle dynamics tests.

7.0 Post Test Disassembly/Prepare for Shipment

- 7.1 Conditioning Chamber Removal
- 7.1.1 Disconnect any hoses and instrumentation that hinders the removal of the chamber.

[1]

- 7.1.2 Using the overhead crane, slowly lift the conditioning chamber off of the vibration table and place on the floor.

7.1.3 Move chamber out of the way.

- r. 2
- 7.1.4 Move the conditioning unit out of the way if necessary.
 7.1.5 Verify motor ground connection on the motor and at the facility ground contact point.
- M

7.1.6 Remove vibration table insulation.

[4



WARNING: Removing the Aero Heat Shield exposes the motor's propellant grain. Personnel should use caution during any operations with and exposed grain. Tools, watches, eye glasses, etc., should be tethered (if necessary) to prevent dropping anything into the 7.2.1 Make sure the motor ground is secured. 7.2.2 Make sure verified wrist straps are being worn by the personnel removing the aero heat shield. Remove the fasteners from the Aero Heat Shield. Place the fasteners in a marked bag. 7.2.3 SLOWLY remove the Aero Heat Shield. 7.2.5 Remove the heat shield seal. Do not drop the seal into the motor. 7.3 Post Test Inspection of Motor Propellant Grain 7.3.1 Make sure motor ground wire is secured. 7.3.2 Clear area of all non-essential personnel. Only the grain inspectors (2) and the MSFC TE shall remain. 7.3.3 Verify grain inspector(s) is(are): a. Wearing 100% cotton coveralls, shorts, and undershirts. b. Wearing a wrist strap. c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor. 7.3.4 Perform grain inspection. Cracked propellant yes If yes, give approximate location and size of crack:

7.2

Aero Heat Shield Removal

ı	Other comments on grain condition:	
	No cracks or other internal defects noted. No motor external Lamage attributable to prostruck or vibration	Testing,
	Grain inspector(s) Algel 9-25-93 Clanto 9-3 MSFC QA	25-93
7.3.	A draw-wire, fabric, security bag shall be installed over the nozzle exit cone. The bag shall be closed around the exit cone and secured by inserting the bag wire ends through a standard security lead-seal (i.e. cover the exit cone the same way that it was received).	W
7.4	Adapter Plate Removal	
7.4.1	Remove the adapter plate to vibration table fasteners.	M
7.4.2	Attach lifting straps as shown in Fig. 1b (Appendix B).	[J]
	CAUTION: Be careful not to disconnect the ground while lifting the motor.	(0)
	CAUTION: The following step involves working with a suspend load. Keep hands and feet out from under the load	led
7.4.3	Lift the motor off of the vibration table and move to an area near the wood supports.	[4
7.4.4	Lower the motor so that it rests on the wood supports.	[4]
7.4.5	Rotate the motor 180° so that the adapter plates face up.	M
7.4.6	Remove the bracket to adapter plate fasteners. Place fasteners in a marked bag.	N
	CAUTION: Be careful not to disconnect the ground while lifting the motor.	
ı	CAUTION: The following step involves working with a suspende load. Keep hands and feet out from under the load.	ed
7.5	Aft Skirt Bracket Removal	
7.5.1	Remove the aft end motor to bracket fasteners (12 places). Place fasteners in a marked bag.	[]



	CAUTIO	N: Be careful not to disconnect the ground while lifting the motor.	e
	CAUTION	N: The following step involves working with a sulposed. Keep hands and feet out from under th	uspended
7	.5.2 Lift the n	notor to waist height using the overhead crane.	
7	.5.3 Rotate the	e motor 180° so that the bracket to adapter plate noles face the floor.	14 (4)
7	.5.4 Lower the	motor so that it rests on the wood supports.	/
(1)	5.5 Remove for Place fast	eners in a marked bag. Light humishing on	[14]
8.0 R	eturn Motor	to the Vertical Position	
8.	1 Attach 2 D to the aft e	-rings, 180 degrees apart, and one lifting strapend holes of the motor.	[4]
8.2		"break-over" brackets (and lifting strap) to the e bolt holes on the forward face of the motor case.	(Y
8.3	Attach the	aft lifting strap to the overhead crane hook	/
	CAUTION:	The following steps involve working with a sus load. Keep hands and feet out from under the	pended
	CAUTION:	Be careful not to disconnect the ground while lifting the motor.	ioad.
8.4	One person strap on the lifted from t it to a vertice	(as chosen by the MSFC TE) shall hold the lifting forward end to keep the motor from swinging when he aft end. Slowly lift the aft end of the motor to bring al position.	(V
8.5	Raise the m	otor so that the aft end is at waist height.	
	CAUTION:	The following steps involve working with a suspload. Keep hands and feet out from under the l	ended oad
8.6	Disconnect t marked bag.	he "break-over" break-to-	N/



BSM MOTOR S/N 1000738 OBSERVATION AND DEVIATION SUMMARY

BSM Observation and Deviation Summary 1993 Delta Qualification Tests at MSFC

Motor SN: 1000738

- #1. Reference step 6.2.1.8 in BSM-TCP-EP54-001. It was noticed after opening the shipping container that the motor to shipping container ground strap was broken. The motor did not appear to have rotated much during shipment. The broken ground strap was placed in the "mass simulator" shipping container and shipped back to CSD.
- #2. Reference step 6.2.1.8 in BSM-TCP-EP54-001. A small dent/scratch was observed on the motor case. This dent/scratch was located at approximately 30° from the forward indicator pin, 3 1/4" from forward end.
- #3. Reference step 6.2.6.4 in BSM-TCP-EP54-001. No cracks or other defects were noted on the propellant grain. A small amount lint and liner particles were observed on the grain. A red stain was also noticed on the grain surface.
- #4. Reference step 6.2.7.7 in BSM-TCP-EP54-001. The aero-heat shield fasteners were very difficult to torque due to the primer in the holes on the exit cone. The primer was removed with 1,1,1 trichloroethane and que-tips.
- #5. Reference step 6.4.5 in BSM-TCP-EP54-001. No damage was observed to the BSM due to the pyro shock test.
- #6. Reference step 6.8.1 in BSM-TCP-EP54-003. No damage was observed to the BSM due to vibration testing. This inspection was performed before any bracket disassembly.
- #7. Reference step 7.3.4 in BSM-TCP-EP54-003. Post-test grain inspection revealed no differences from the pre-test inspection.
- #8. Reference step 7.5.1 in BSM-TCP-EP54-003. Light burnishing marks were observed on the motor case after removal of the aft attach bracket.
- #9. Reference Test Procedure Deviation item 3 for BSM-TCP-EP54-003. The forward bracket attach fasteners were torqued per step 6.2.2.4 in BSM-TCP-EP54-001 (150 in-lbs). These fasteners were not lockwired on this motor. After finishing the radial axis tests, the lead vibration engineer noticed two fasteners laying in the forward bracket. Further inspection showed that in addition to the two fasteners out, four were loose.

What Bevill

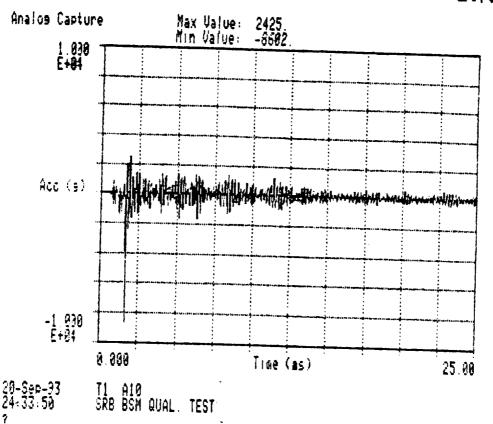
Photographs were taken. USBI, CSD, and MSFC agreed to retorque the fasteners and proceed with the testing. The torques were verified with a different torque wrench after re-torquing with the same wrench used at assembly. The test team also decided to re-check these torques after each axis.

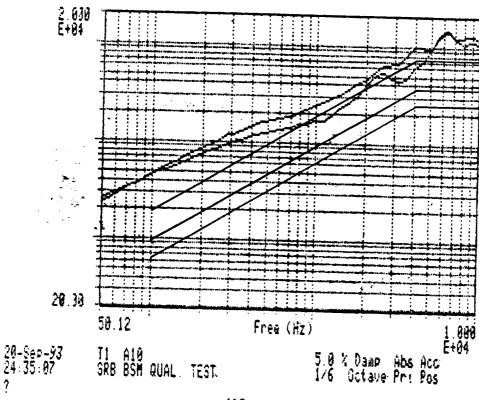
A deviation was also written for the test sequence of the radial axis tests (see Test Procedure Deviation items 1 and 2 for BSM-TCP-EP54-003). The boost vibration time duration should be 120 seconds as stated in BSM-TCP-EP54-003 step 6.2.3.1. However, a USBI representative noticed that the boost vibration test was only conducted for 60 seconds. He also noticed that the lift-off vibration test was one second short (test tolerance on test duration is +10%, -0%). This deviation was discovered after the motor had already been unfastened from the table. So, the motor was re-connected to the table and brought back to temperature. Conditioning chamber temperature was resumed 24.5 minutes after chamber removal so no reconditioning time was necessary. The final 60 seconds of the boost test and the one second on lift-off were then completed. The response data indicated that the forward fasteners probably came loose at about 30 seconds into the boost sequence. This means that the forward fasteners were probably already loose before the chamber was re-connected to finish the last 60 seconds.

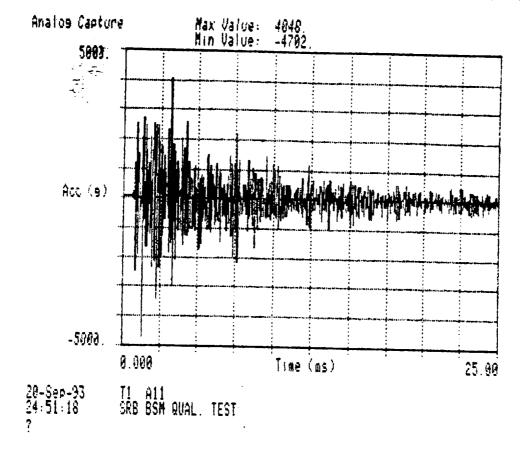
- #10. Reference step 7.5.5 in BSM-TCP-EP54-003. Chatter marks were evident on the forward face of the motor case. These marks were caused by the forward fasteners coming loose during the radial axis test allowing the bracket and the motor to rub. Burnishing marks were also evident on the forward face of the motor.
- #11. Reference step 6.8 in BSM-TCP-EP54-003. After all of the vibration testing was complete, the post-test inspection revealed four aero-heat shield fasteners were missing. Several other fasteners were loose. The aero-heat shield was still secured to the exit cone, however, and did not appear to move during testing.

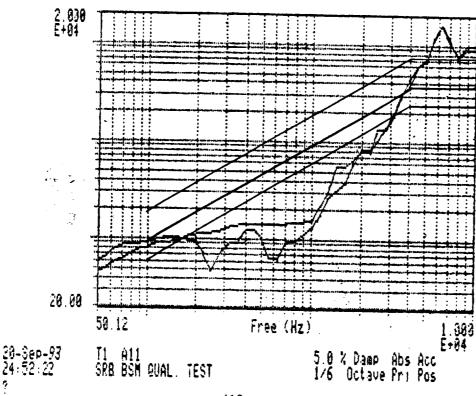


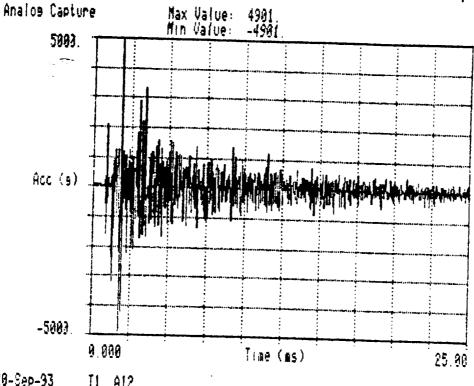
				Figure 1		
	· · · · · · · · · · · · · · · · · · ·	<u> </u>	TEST PROCE	DURE DEVIATION		BSM-TCP-EP54-001
Mat Bevill NB 09/29/93 Meaumements engineer:				RICK Clements Re	9-29-93	09/29/93
T (2		_		Richard Leonard (suf	ety) RB 9-29-93	SHEET OF 6
į	Upper	Limit	Tolerance Vio	lation for Pyro SI	hock Simulation	in Test (sn: 1000738)
XEV. NO.	PAGE	SEO.		OHANGE/R		PER TED
			test tolera tods and shock spec The worst co	2.1 in BSM-TCP-Ences for Shock 1 -3dB when analytem analytem analytem are ase overtest for each graphs. X-axis: acceleromete Y-axis: acceleromete Z-axis; acceleromete 1000738	Response Spetzed with a and 5% damp ach axis is er #10	es that the Ctrum are Vs octave Ving. shown in
			Jim He	Erring Jub- He Erris, Lead Priv	erma	
GINAT					-	
esta T	Mi	t Bai	i10		ORGANIZAT	
VE DE	VIATION	ISI INCRE	ASE HAZARD LEVEL:	Kerny Han	MASA MS	FC EP12 ATIONISI AFFECT TEST REQUIRE-



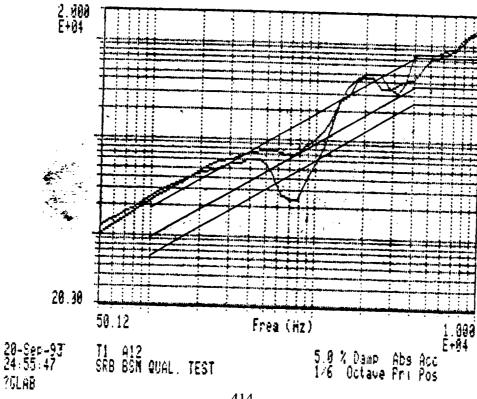




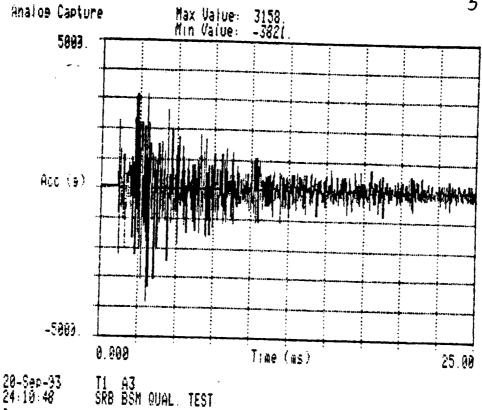


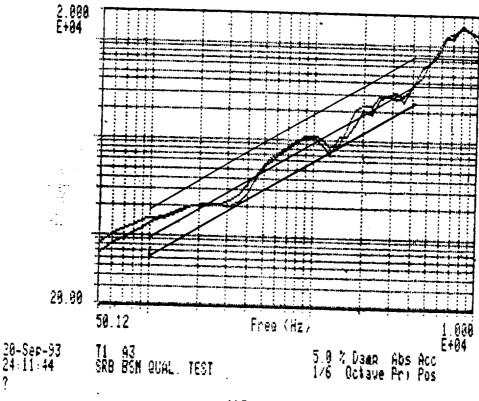


28-Sep-93 24:53:52 T1 A12 SRB BSM QUAL, TEST









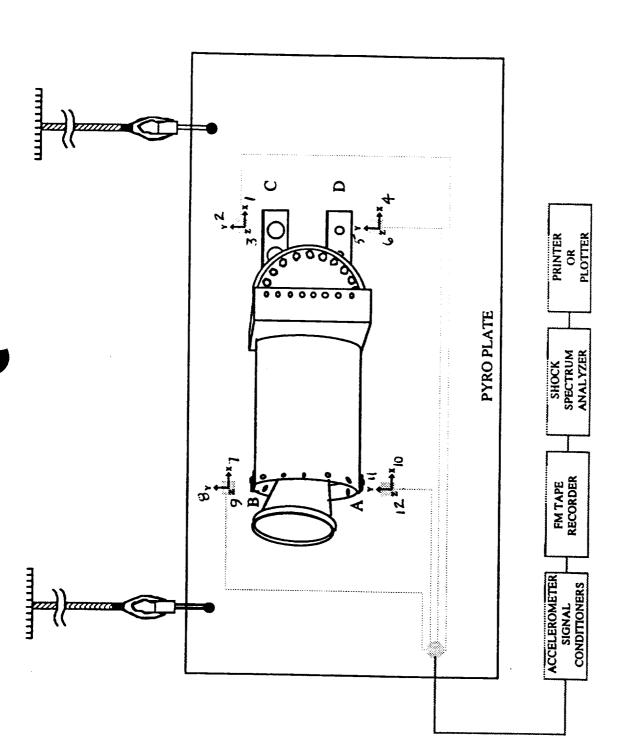


FIGURE 1. PYRO SHOCK CONTROL EQUIPTMENT

CAUTION: When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.

> After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may continue.

If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety, and evacuate all personnel to safe locations as directed by safety.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

Slowly, monitoring static charge, lift the motor out of the 6.2.1.8 container using the overhead crane. Lower the test item so that the forward end of the motor is at waist height.

A detailed visual inspection shall be performed by the MSFC test engineer and the CSD test engineer on the live test items before testing. Record the motor's serial number.

No Damage

Damage (detail in attachment) Yes, motor to shipping container ground wire Serial Number 1000738 ful indicate 30 form the Ken-

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

Attach the "break-over" brackets and lifting strap on 6.2.1.9 the forward end of the motor (see Figure 2, Appendix C).

CAUTION: Do Not disconnect the ground wire while breaking the motor to the horizontal position.

	Record SN of torque wrench: "["EMJ00359 A,B,D T- 261-62 (46	11)
6.2.5.2	actions wie verision from the lifting strong but 1.	(T
6.2.5.3	Place the pyrotechnic debris shield in front of the large bay doors on the north side of the pyro room.	W
6.2.6	Perform Grain Inspection	
6.2.6.1	Clear area of all nonessential personnel for grain inspection. (Only the grain inspectors (2) and the MSFC TE shall remain.)	4
6.2.6.2	Verify grain inspector(s) is(are):	/
	a. Wearing 100% cotton coveralls, shorts, and undershirts.	, 1
	b. Wearing a wrist strap.	
	c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.	
6.2.6.3	The grain inspector shall now remove the security bag and cover from the exit cone.	1
6.2.6.4	Perform grain inspection.	
	Cracked propellant? yes	
	If yes, give approximate location and size of crack.	
		-
	Other comments on grain condition: No cracks or other defects noted	
\	Propellant grain, small amounts of lint	
	Grain inspector The Street TABMSFC QA	
6.2.7 Ins	Grain inspector B & Selly 7.30-3	1
_	stall Aero Heat Shield	/

CAUTION: When using trichloroethane, personnel shall wear chemical goggles and Neoprene-Latex gloves.

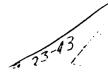
Contaminated materials shall be disposed of as hazardous waste.

7.20 13

6.3.7	On the count of "3", the pyro technician shall put the switch in the "ARMED" position and verify that the power indicator is illuminated.	M
6.3.8	On the FIRE command, the pyro technician will open the red cover and flip the firing switch.	M
6.3.9	After firing, turn the firing panel key to the "UNARMED" position.	M
	WARNING: If blasting cap does not fire, refer to Section 10.4 in ED73-SHK-FOP-004 (see Appendix A).	
	Blasting Cap Fired: yes no	
6.3.10	Remove the arming key and disconnect the voltage supply.	N
6.3.1		[]
6.3.12	Wait a minimum of 5 minutes after firing before opening the door to room 170.	[6]
6.3.13	The lead pyro engineer shall now begin to reduce the data.	FΊ
6.4	Post Test Inspection	.,
6.4.1	Inform the MSFC TE that the door to room 170 from the control room is to be opened.	Ŋ
6.4.2	The pyro technician shall enter room 170 and move the junction box switch to the "BULB" position.	(y)
6.4.3	Remove blasting cap leads from junction box.	ry
6.4.4	Inspect the shock plate to insure all explosive devices fired properly.	M
~	WARNING: If all explosive items did not fire, refer to Section 10.5 in ED73-SHK-FOP-004 (see Appendix	A).
6.4.5	The BSM shall be visually inspected for damage resulting from the pyro shock test. Any anomalies will be recorded. All other personnel shall remain in the control room or in the clear area until the "ALL CLEAR" is given by the MSFC TE.	M
6.4.6	MSFC TE indicates all clear for appropriate personnel.	[M
6.5	Post Test Removal from the Pyro Plate	- · •

6.7.3 Vehicle Dynamics 6.7.3.1 The following levels and conditions apply for the vehicle dynamics test. Vibrate the motor only as follows. Frequency (Hz) Level 5 to 10 0.7 g peak 10 to 40 4.3 g peak Sweep Rate: 3 octaves per minute 6.8 Post Test Inspection The BSM test item shall be visually inspected by the MSFC QA, 6.8.1 MSFC TE, and the CSD TE for exterior damage resulting from vibration testing. 6.8.2 Remove all instrumentation. [X]6.9 Data Requirements Power Spectral Density (PSD) plots for all control and response accelerometers for lift off and boost tests shall be recorded. The test tolerances shall be overplotted on the control accelerometers plots. Acceleration versus frequency plots shall be recorded for all accelerometers used during vehicle dynamics tests. Post Test Disassembly/Prepare for Shipment Conditioning Chamber Removal 7.1 7.1.1 Disconnect any hoses and instrumentation that hinders [W the removal of the chamber. 7.1.2 Using the overhead crane, slowly lift the conditioning chamber off of the vibration table and place on the floor. 7.1.3 Move chamber out of the way. 7.1.4 Move the conditioning unit out of the way if necessary. 7.1.5 Verify motor ground connection on the motor and at the facility

7.0



ground contact point.

7.1.6 Remove vibration table insulation.

7.2 Aero Heat Shield Removal WARNING: Removing the Aero Heat Shield exposes the motor's propellant grain. Personnel should use caution during any operations with and exposed grain. Tools, watches, eye glasses, etc., should be tethered (if necessary) to prevent dropping anything into the motor. 7.2.1 Make sure the motor ground is secured. 7.2.2 Make sure verified wrist straps are being worn by the personnel removing the aero heat shield. 7.2.3 Remove the fasteners from the Aero Heat Shield. Place the fasteners in a marked bag. 7.2.3 SLOWLY remove the Aero Heat Shield. 7.2.5 Remove the heat shield seal. Do not drop the seal into the motor. 7.3 Post Test Inspection of Motor Propellant Grain 7.3.1 Make sure motor ground wire is secured. 7.3.2 Clear area of all non-essential personnel. Only the grain inspectors (2) and the MSFC TE shall remain. 7.3.3 Verify grain inspector(s) is(are): a. Wearing 100% cotton coveralls, shorts, and undershirts. b. Wearing a wrist strap. c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor. 7.3.4 Perform grain inspection. Cracked propellant yes no If yes, give approximate location and size of crack:

	_
Other comments on grain condition:	
NO PIFFERENCES NICTUP FROM PRE-TOST IN-FILL TICKE	_ \
Grain inspector(s) Slaton R. Selly MSFC QA	— —
7.3.5 A draw-wire, fabric, security bag shall be installed over the nozzle exit cone. The bag shall be closed around the exit cone and secured by inserting the bag wire ends through a standard from security lead-seal (i.e. cover the exit cone the same way that it was received).	[4]
7.4 Adapter Plate Removal	
7.4.1 Remove the adapter plate to vibration table fasteners.	M
7.4.2 Attach lifting straps as shown in Fig. 1b (Appendix B).	M
CAUTION: Be careful not to disconnect the ground while lifting the motor.	,
CAUTION: The following step involves working with a susper load. Keep hands and feet out from under the loa	ided d.
7.4.3 Lift the motor off of the vibration table and move to an area near the wood supports.	M
7.4.4 Lower the motor so that it rests on the wood supports.	M
7.4.5 Rotate the motor 180° so that the adapter plates face up.	rs ·
7.4.6 Remove the bracket to adapter plate fasteners. Place fasteners in a marked bag.	[V
CAUTION: Be careful not to disconnect the ground while lifting the motor.	
CAUTION: The following step involves working with a suspen load. Keep hands and feet out from under the load	ded l.
7.5 Aft Skirt Bracket Removal	
7.5.1 Remove the aft end motor to bracket fasteners (12 places). Place fasteners in a marked bag. **	M
* LIGHT SCORING OF SUPPACE AT THE	
AFT BRACKET ATTACHMENTS. IH 9/23/93 DC 9-23-93	
422 MB 1/23/93	/

CHATTER MARKS EVIDENCT ON MI (4/13/17)
FORWARD FACE OF THE INCTOR. EH 9-23-93
PC 9-23-93
Py 8 9-23-93

CONDITIONS TO POST TEST INSPECTION (6.8)

LOCSE ARRI HEAT SHIELD BULTS

0 - Missing Bouts (GTy 4) 0 - LOOSE BUTS (GTy 3) &-OKAY

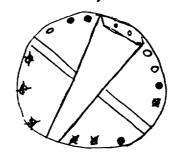


Figure 1

·			Figure 1
			TEST PROCEDURE DEVIATION BSM-TCP-EP54 - 00
TEST E	Mat	- Be	Will 9-22-93 Rick Clements PL 9-12-93 OATE OTHER OTHER
AEQUIA	REMENTS	ENGINE	Richard Leonard Py 8 9-22-93 SHEET 1 or 2
TITLE.		Radi	al Axis, Boost Vibration time Limit (motor 1000738)
NO.	PAGE	SEQ.	OHNGEREASON PE
1			Boost vibration time duration should be 120 sec To as stated in BSM-TCP-EPS4-003 step 6.2.3.1.
			Bost vibration test was only conducted for 60 sec. Conditioning equipment and instrumentation were re-connected. Chamber temp was resumed 24.5 minutes after chamber removal. Testing was resumed per NOTE: in section 8.0 in BSM-TCP-EPS4-002. The final 60 secs. were finished after chamber resumed temp.
2			Credict Axis) Lift off Vibration timed was short by 1 sec. Once the chanter resumed temperature (see Dev. Ichore) the test was resumed. (i.e. Lift off vibrationwas performed for one in one second.) Time tolerand as stated in 4.2.1 has time tolerand of 116%, -0%
AIGINA	TOA:		
	1/0	of le	Perill OAGANIZATION: EP12

Figure 1

				•	TCP NO	
			TEST PROCE	DURE DEVIATION	Bim-T(P-EPS4-)(T
1	Nat f	Bevill	N.2011rgas	RICK Clements RC 9-22	DATE	
TITLE:	<u></u>			Richard Leonard Page 9-	2245 SHEET 2 OF Z	• •
DEV.	PAGE	7 BY	acket to mo	tor attach fasteners loop	eved during Vibration	·
	PAGE	SEQ.		OHANGE/REASON		PERM
3			Afterfinishing Afterfinishing Donling the the the the the the the the	radial axis boost vibra was natured that e, 2 were camplete Photographs were taken were re-tarqued per-EPSA-001 (150:11-15 rench). These tarques other torque wrench	then test (seeder. 1) 4 fasteners were in 17 out, and 2 were r 6.2.2.4 in is with the same were then berified	T
DRIGINA NBOVE C	Mc Mc	i	INCREAGE 1	THE HAZARD LEVEL, H THAT THEY CAME LO D INCREASE THE HAZ 426	TEP G.Z.Z.A DUES NOT POWER, AS STATED ABOUT OSE BURING VIBRATION WILL ARD LEVEL, SESCHIONS WILL ORGANIZATION: EPIZ ABOUT DEVIATIONISI AFFECT TEST A MENTS.	BE TAPPE

1	Verify test program and re	cord the abort	level below	·
	Abort Level	186		. •
2	Perform levels as defined	below and verif	y with plot	. <u>v</u>
3	Record the following:		• •	
	Amplifier Gain	4070	<i>‡</i>	-
	Charge Amp. F.S.	106		
		- · · · · · · · · · · · · · · · · · · ·	· •	
	* * * * * * * * * * * * * * * * * * *			. •
	•			
	510	Hz at <u>.076</u>	,limit	<u> </u>
	10 - 40	Hz at 3.7 G	,limit	<u> + 1.5</u> dB
		Hz at	,limit	dB
		Hz at	,limit	dB
		Hz at	,limit	dB
	Sweep Rate = 3	oct/min		
	Test level concurrence: _			

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page_____of

LIFT OFF RANDOM

Verify test program and record RMS abort limit below. RMS abort limit	ENTIA
.2 Perform levels as defined below and verify with plot. .3 Record the following: Amplifier Gain 70% Charge Amp. F.S. 306	
.3 Record the following: Amplifier Gain 70% Charge Amp. F.S. 306	
Amplifier Gain 70% Charge Amp. F.S. 306	
Charge Amp. F.S. 306	
<u>20 %z e .016</u> G²/%z, linits <u>+.3,-1.3</u>	
20 Hz e .016 G ² /Hz, linits +.3,-1.5	-
20 Hz e .016 G ² /Hz, linits +3,-1.5	. 5
	Jb
75 Ez - 1000 Ez a 1060 " linits "	_
E= - <u>2000</u> =z @ <u>.030</u> linits'	_
E: E: @ linits	
Ez Ez @ linits	_
Ez Ez @ linits	_
E2 E2 8 linits	_
	
E:	
Composite = 10 Gras	
Test Time = 60 Sec.	
Test Level Concurrence: Component Assessment Branch Date	

BOOST RANDOM SN 1000773

RANDOM CHICK-COL			λI	es T <u>angent</u>	TA.
Verify test progra	a and record RMS a	bort libit	below.		
RMS abort 1	init	ć3			
Perform levels as	defined below and	verify with	h plot.		
Record the followi	nç:				
Amplifier G	80.7	<u></u>			
Charge Arp.	F.S. 100 G				
	·				
					\$
-	Ez e	G ² /E=,	limits _	+3-1.5 ds	5
	20 Ez e .24				
E= - <u>20</u>	00 =z e <u>.01</u>	1_	lizits _	/(
E:	Ez ê		limits _		
Ez	Ez 0	· 	limits .		
	Ez @		linits		
E2	Ez @		limits .		
	== 0		limits .	·	
	Rz ê		limits		
Composite	= <u>18.4</u> GES				
Test Time	= <u>120</u> Sec.				
Test Level Concu		Assessment		Date	_

- HIGLE SYNA	MICS CHECK-OUT		AXIS	TANGENT
	Verify test program and a	199		
1.2	Perform levels as define	d below and verif	y with plot.	<u> </u>
1.3	Record the following:	•	**	
<u></u>	Amplifier Gain	40 90		
	Charge Amp. F.S.			· ·
ing a second				
~	5	Hz at7		dB
•		Hz at		
:		Hz at	,limit	dB
<u>.</u>		Hz at	,limit	dB
		Hz at	,limit	dB
	Sweep Rate = 3	oct/min		: :
	Test level concurrence:			
		Component Assess	ment Branch	Date

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page_____of

LIFTOFF RANDOM SN 1000738

		745 show	- 1:-:-		is Longi
Verify test program				percy.	
RMS abort li			• •		
Perform levels as d	efined belo	w and ver	ity with	plot.	
Record the followin	Ġ:				
Amplifier Ga					
Charge Amp.	F.S	306			•
	20 Ez a _	.016	G ² /H:,	limits _	+3 -1.
75 ==10					
E= - <u>20</u>	<u>0.0</u> =z e _	.03		limits _	/1
=======================================	Ez @			linits	
	E: 0 _			limits .	
				linits	
				l <u>ini</u> ts	. -
EI	•			linits	
E2					
Composite =					
Test Time =					
	~	· •			

BOD- T KANDOM SN 1000738

•	<u></u>	••••	
Perform levels as	defined below an	d verify with plot	<u> </u>
Record the follow		•	
Amplifier (Sain <u>85</u>	•	
Charge Arp	. F.S. <u>100</u>		
		G ² /Hz, liai	=5 <u>+3,-1.</u>
<u>20</u>	800 Ez e		TS
Ez2	.00.6 Ez @	217 1:11	.ts
==	≡= €		.ts
Ez	E: 0		.ts
	== 0		ts
==			its
	== 0	lin	its
==			<u>:</u> ts
Composite	= <u>18.4</u> GIES		
Test Time	= <u> 10</u> Sec.		

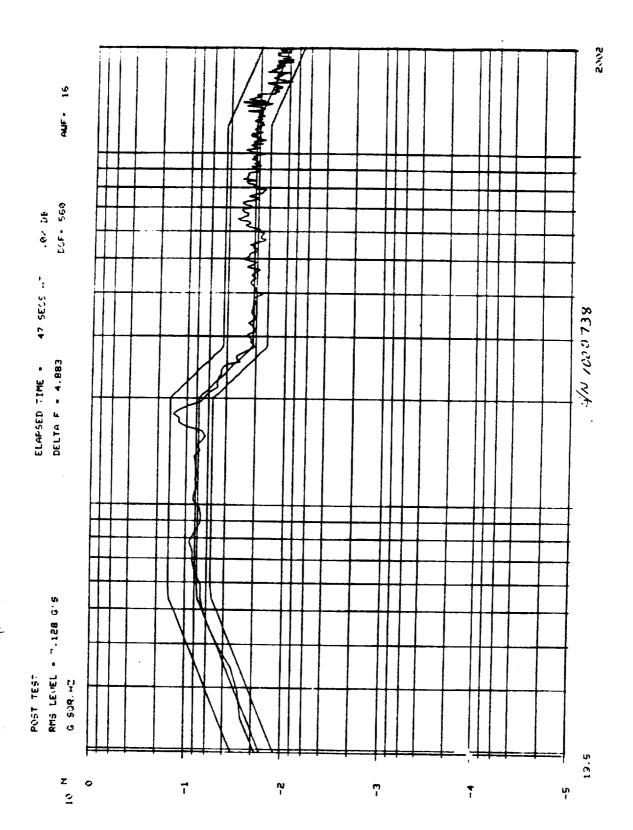
VEHICLE DYM	AMICS CHECK-OUT	÷	<u>Ax</u>	IS LONGITUDI
	Verify test program and			<u> </u>
	Abort Level	LGb_		
1.2	Perform levels as define	ed below and veri	fy with plot.	<u>v</u>
1.3	Record the following:			
	Amplifier Gain	4070		
n Time	Charge Amp. F.S.			
•	=· •	Hz at7		
·		Hz at Hz at		
-		Hz at	,limit	dB
		Hz at		
	Sweep Rate =3	oct/min		
	Test level concurrence:	•	 . -	
		Component Asses	sment Branch	Date

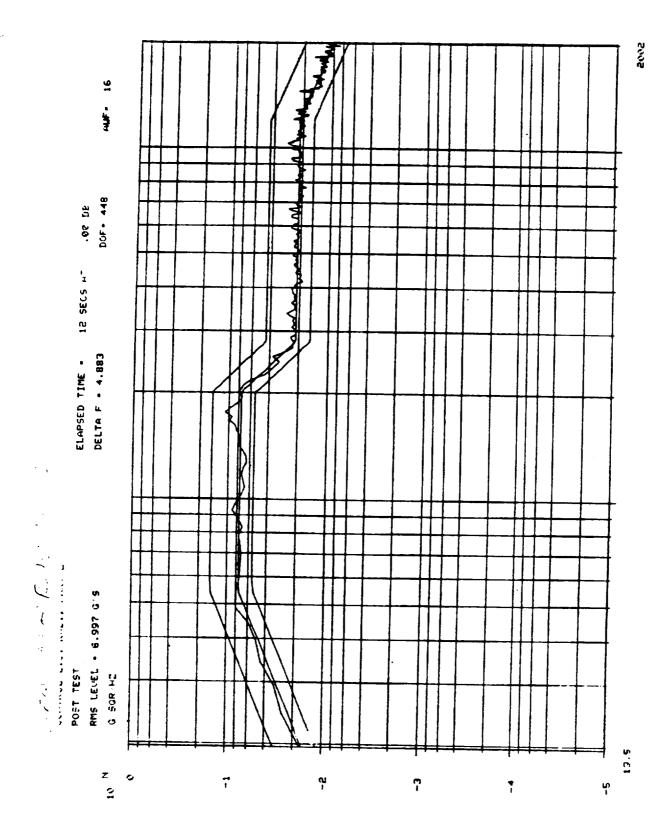
RANDOM TEST LIFTOFF LONGITUDINAL TANGENTIAL. Record a minimum of 30 seconds of calibration signal on tape recorder. VVV Set full scale ranges on instrumentation amplifiers and . 2 note on data sheet. 101 Set power amplifier gain to position noted during random ..3 test check-out. V V V Perform self check of control system. 111 Begin test sequence at - 9 dB from full level. 111 At - 6 dB, start tape recorder. Note time when full level is reached. See lare Log 111 At the completion of the test, set power amplifier gain 1.8 to off. 111 1.9 Stop tape recorder. 111 1.10 Inspect test article for damage or degradation. 111 1.11 Remove test article from shaker. 111

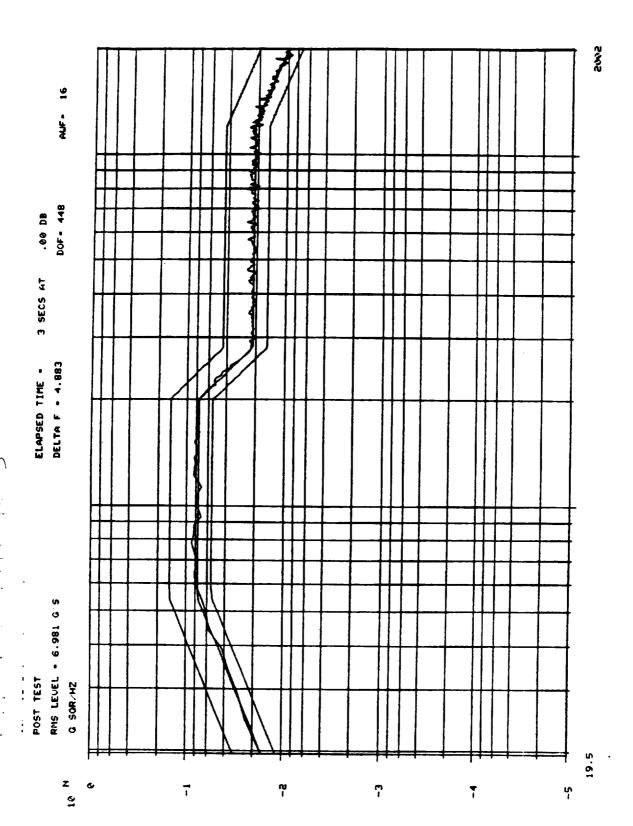
÷	RANDOM TEST Boost	RAVIAL T <u>ANGENTIAL</u> LONGITUDIUAL
,1	Record a minimum of 30 seconds of calibration signal on	
	tape recorder.	<u> </u>
.2	Set full scale ranges on instrumentation amplifiers and	
	note on data sheet.	<u> </u>
.3	Set power amplifier gain to position noted during random	
	test check-out.	<u> </u>
.4	Perform self check of control system.	<u> </u>
. 5	Begin test sequence at - 7 dB from full level.	
. 6	At - 6 dB, start tape recorder.	41
7	Note time when full level is reached. JeeTHELOG	111
8	At the completion of the test, set power amplifier gain	
	to off.	011
L.9	Stop tape recorder.	100
1.10	Inspect test article for damage or degradation.	111
1.11	Remove test article from shaker.	41

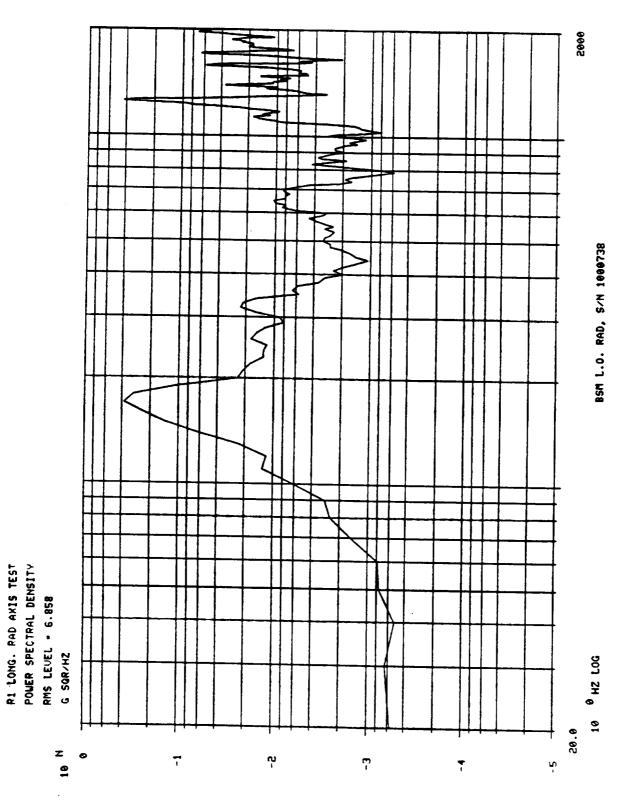
		<i>SN_1000738</i>	
<u>)E</u> :	(ICLE DY	NAMICS TEST AXIS	RADIAL TANGENTI
	1.1	Record a minimum of 30 seconds of calibration signal on	
		tape recorder.	VVV
	1.2	Set full scale ranges on instrumentation amplifiers and	
		note on data sheet.	vv V
	1.3	Set power amplifier gain to position noted during sine	
		test check-out.	VVV
	1.4	Perform self check of control system.	v / V
	1.5	Start tape recorder.	~ / /
	1.6	Begin sine sweep.	V V Y
	1.7	Note time of DCS "SWEEP UP" or "SWEEP DOWN" indication	
		light. See TAPE LOG	- 1 v
	1.8	During first sweep, press the "SAVE" button on DCS.	<u>, 1 /</u>
$\overline{}$	1.9	If more than one sweep, note time of DCS "SWEEP UP" or	
		"SWEEP DOWN" indication light.	
	1.10	At the completion of the sweep, set power amplifier	
	,	gain to off.	1 1 V
	1.11	Stop tape recorder.	VV
	1.12	Inspect test article for damage or degradation.	VVV

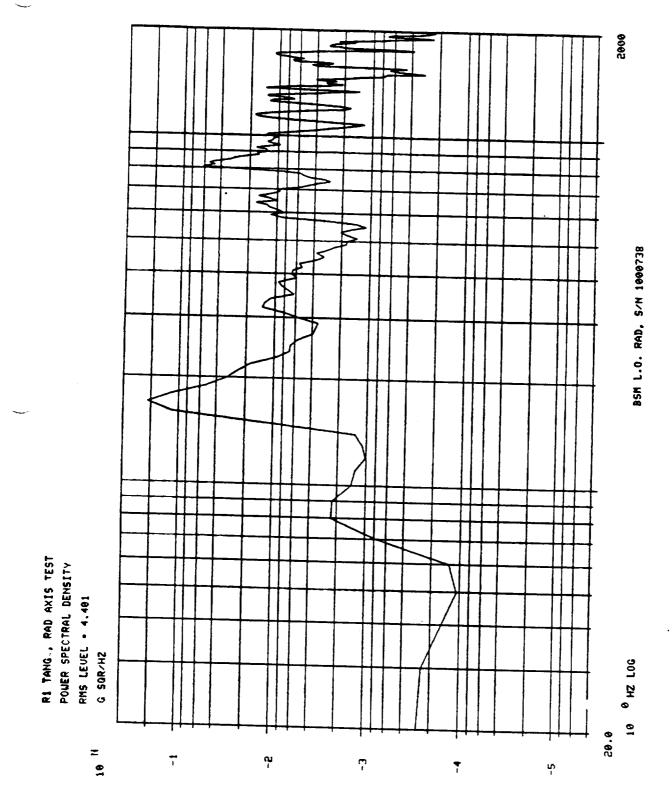
SN 1000738 Test Data RADIAL AXIS
RANDOM, LIFT-OFF

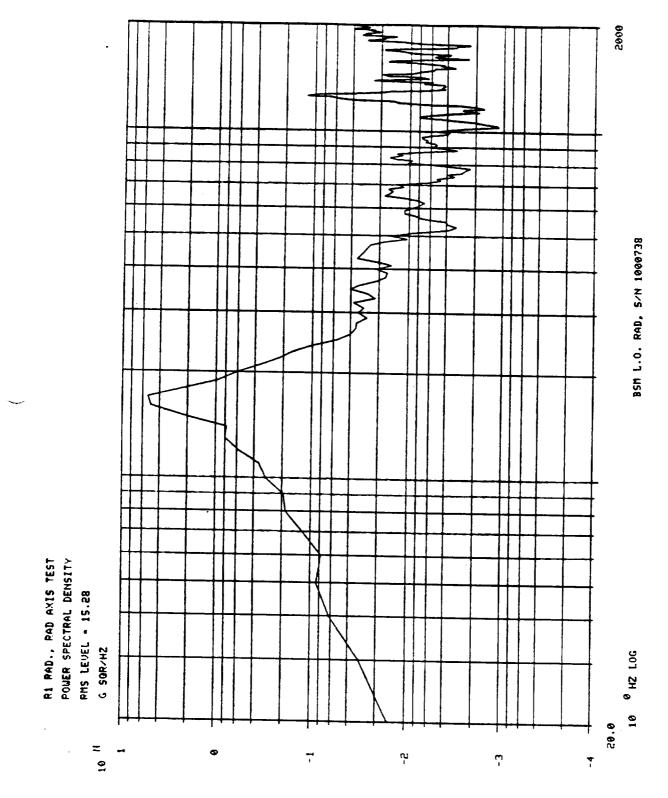


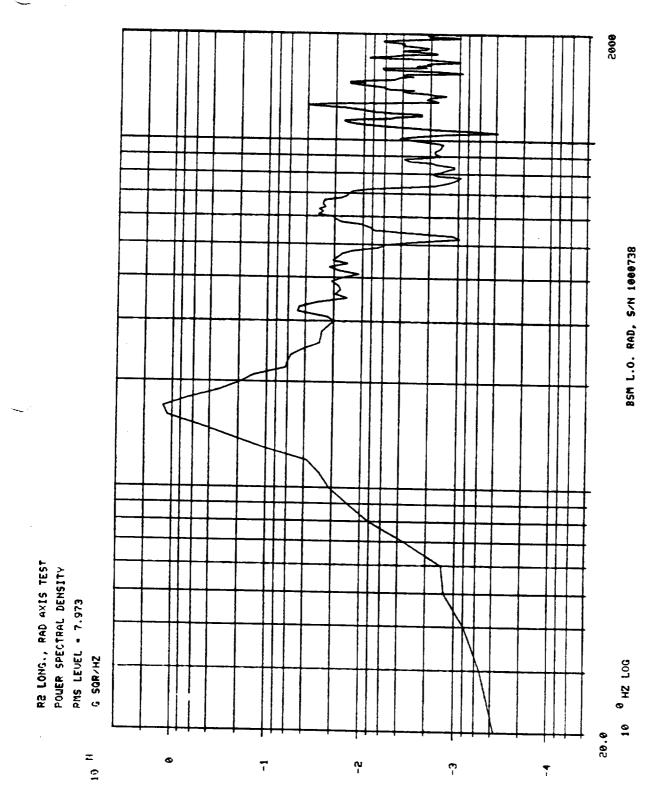




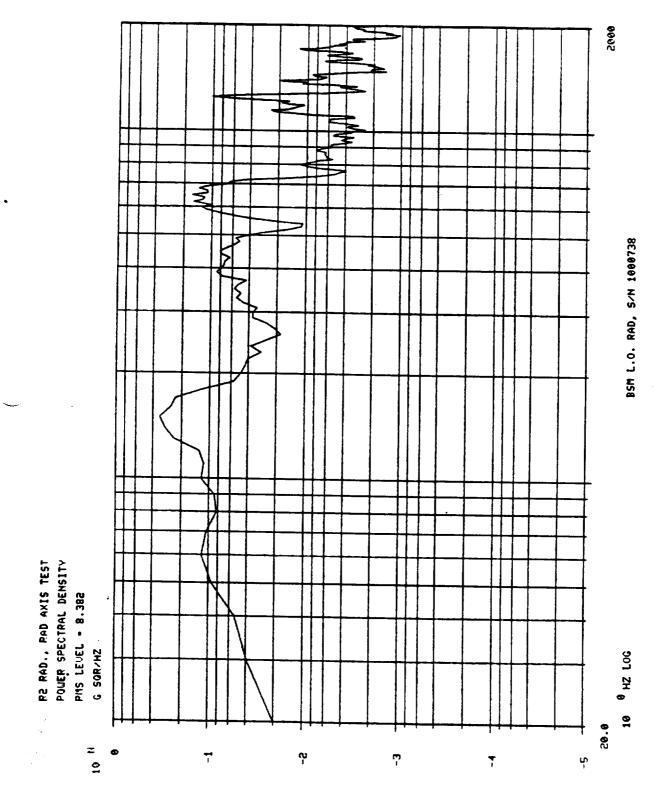




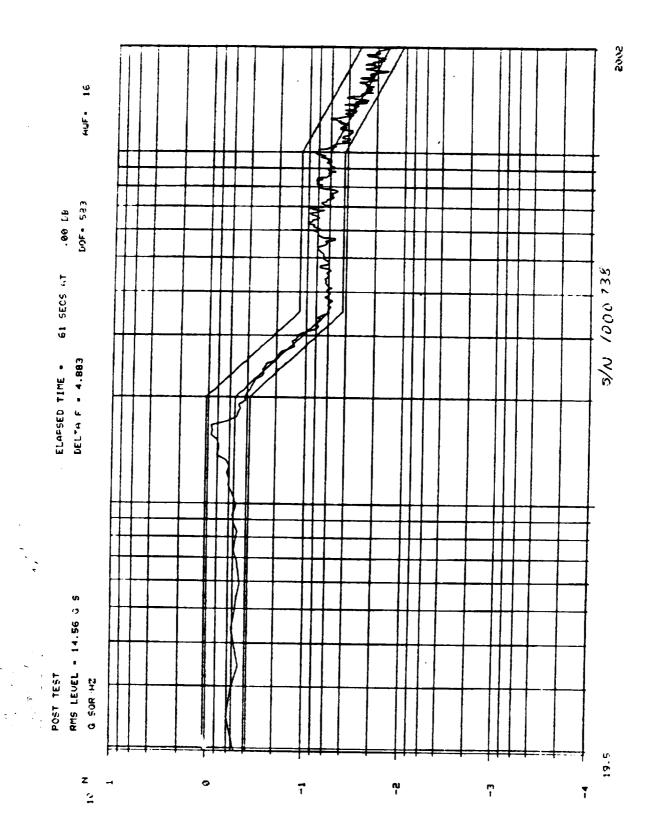


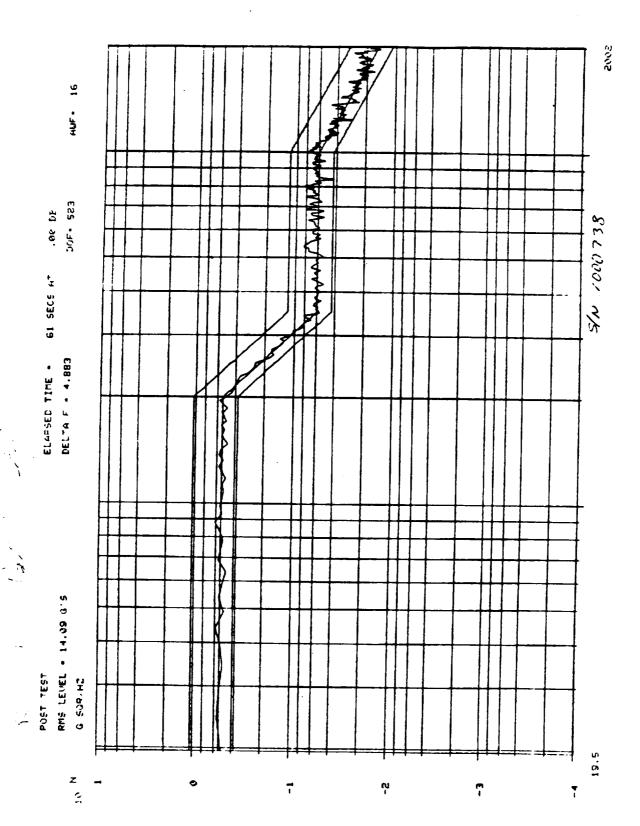


2000 BSM L.O. RAD, S/N 1000738 RE TANG., RAD AXIS TEST POWER SPECTRAL DENSITY PMS LEVEL • 3.104 G SOR/HZ 10 0 HZ LOG **2** 01 7 လု က 7 ċ

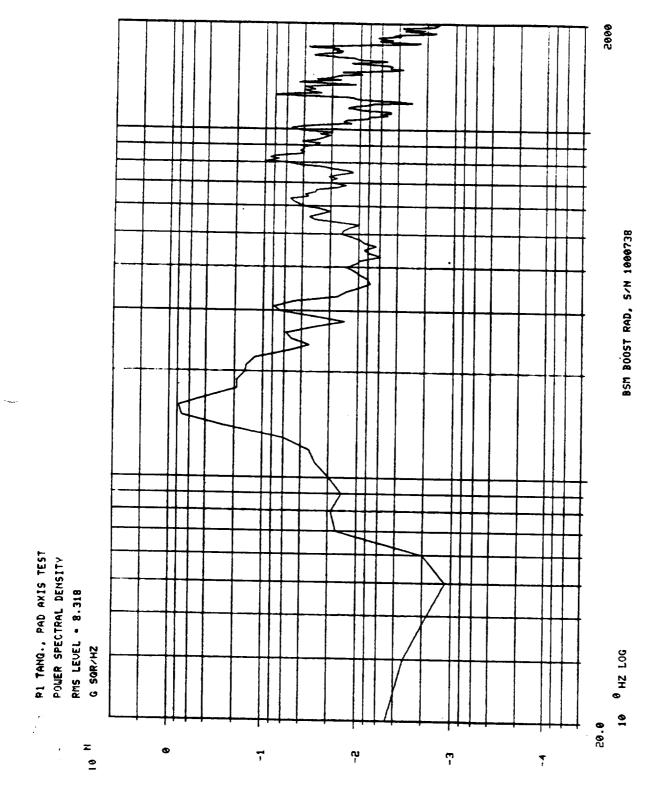


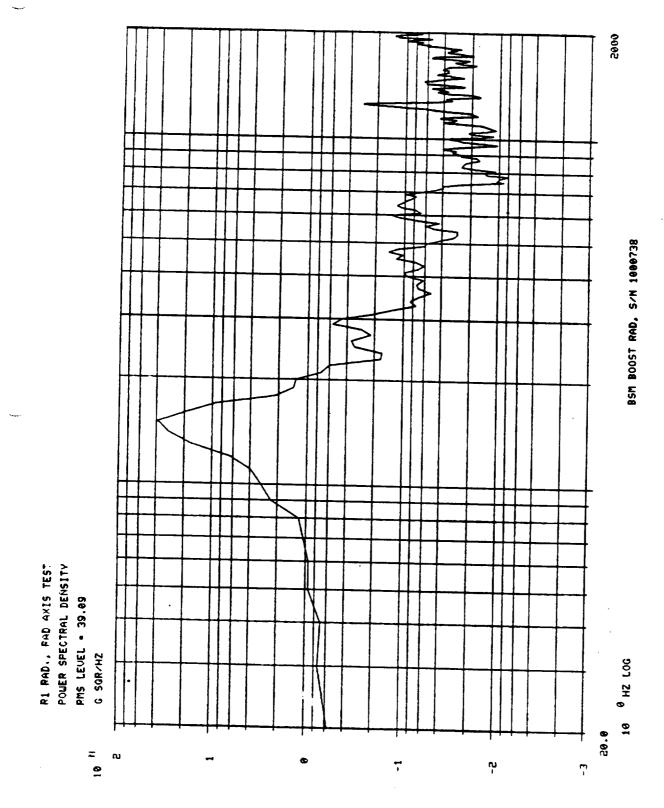
RADIAL AXIS
RANDOM, BOOST





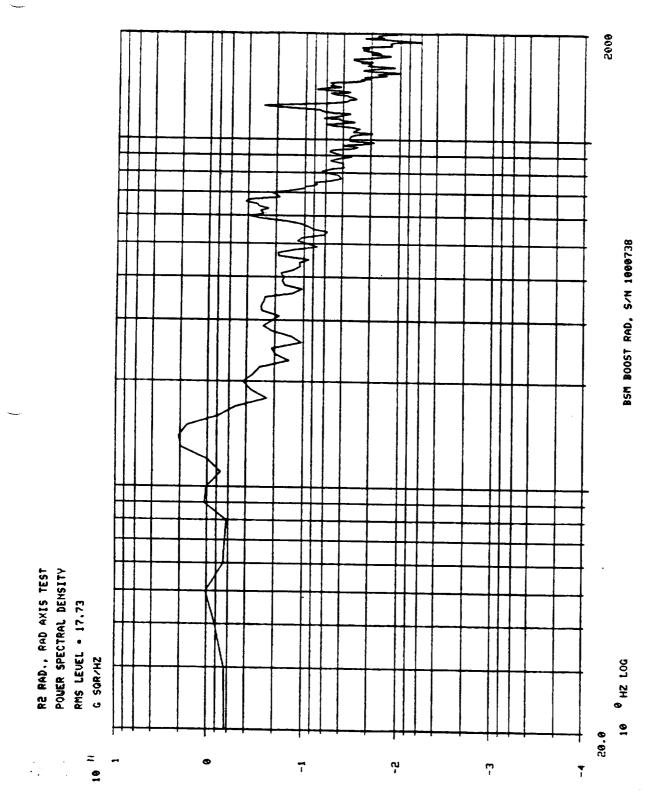
2000 BSM B005T RAD, 5/N 1000738 PI LONG., RAD AXIS TEST POWER SPECTRAL DENSITY RMS LEVEL - 14.34 G SGR/HZ 10 0 HZ LOG 20.0 10 1 9 7 5 £-7





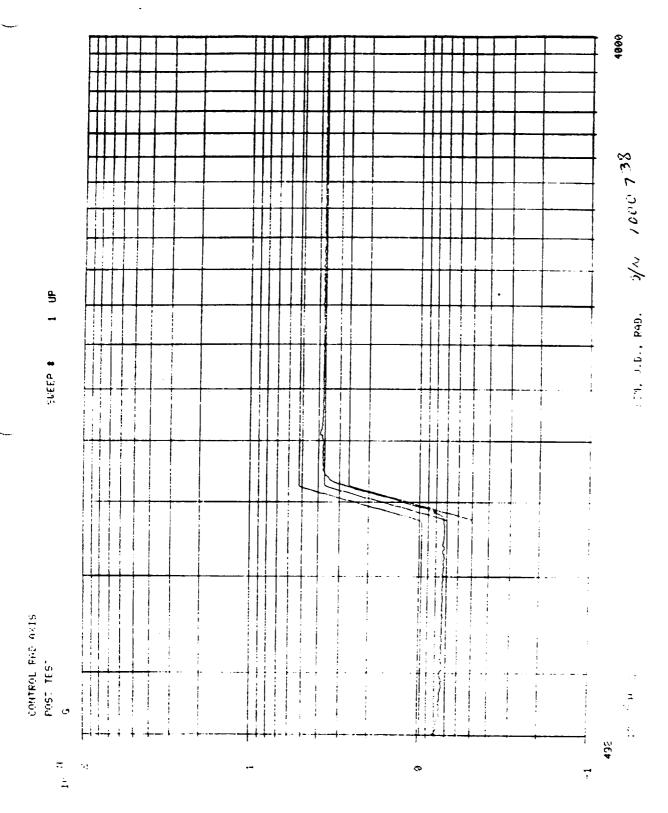
BSM B005T RAD, S/N 1000738 PA LONG., RAD AXIS TEST FOWER SPECTRAL DENSITY RMS LEVEL • 20.18 G SOR/HZ 10 0 HZ LOG ≃ 10 1 -1 ကူ £.

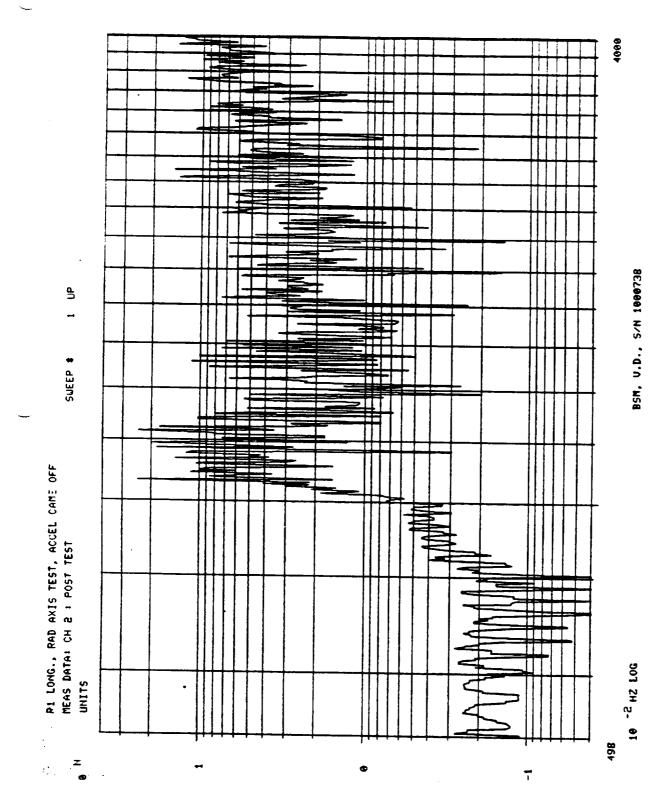
2000 BSM B005T RAD, S/N 1888738 RE TANG., PAD AXIS TEST POUER SPECTRAL DENSITY PMS LEVEL • 9.726 G SOR/HZ 10 0 HZ LOG N 81 -Ġ ç 7

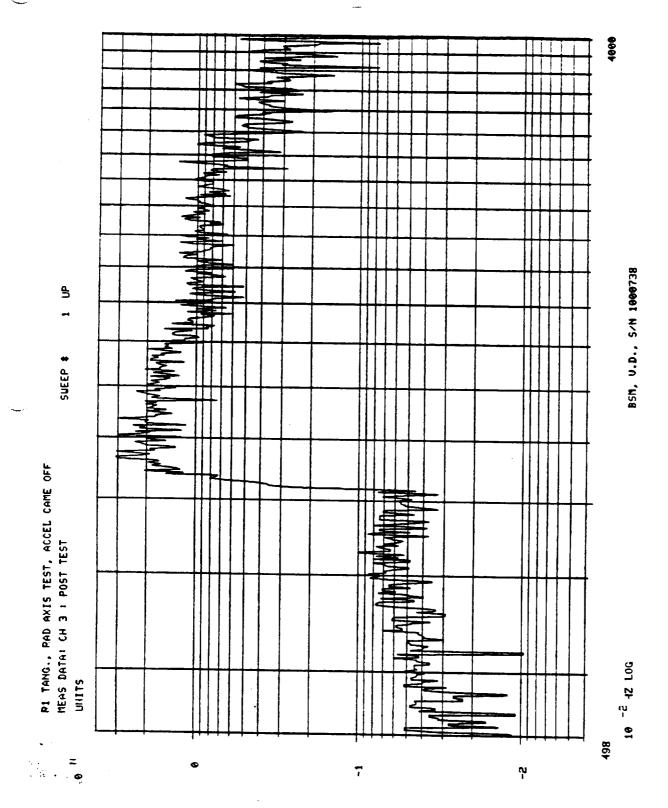


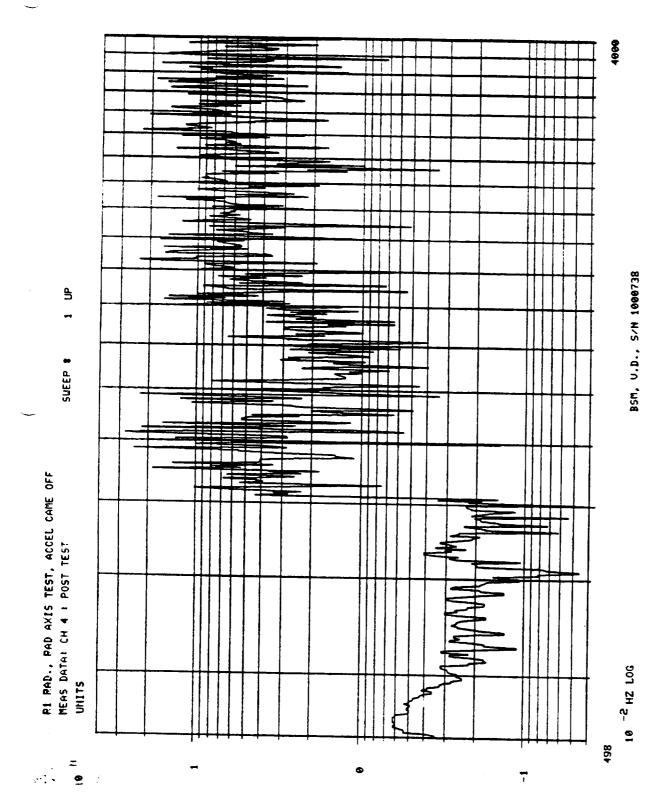
RADIAL AXIS

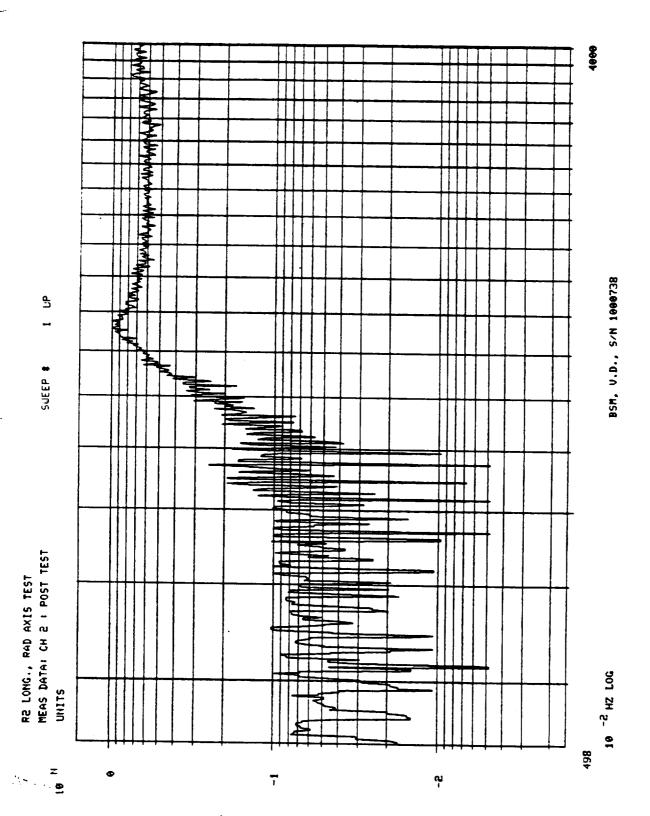
VEHICLE DYNAMICS

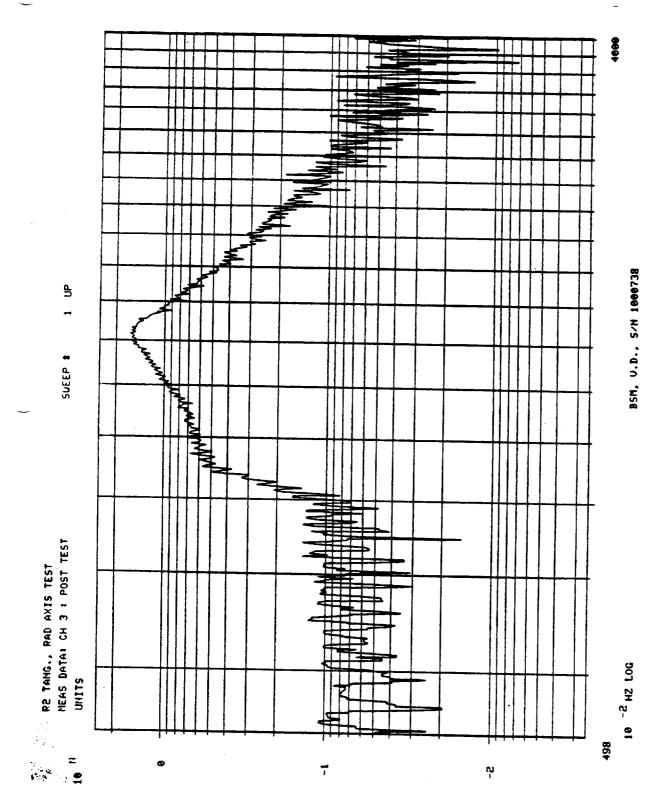


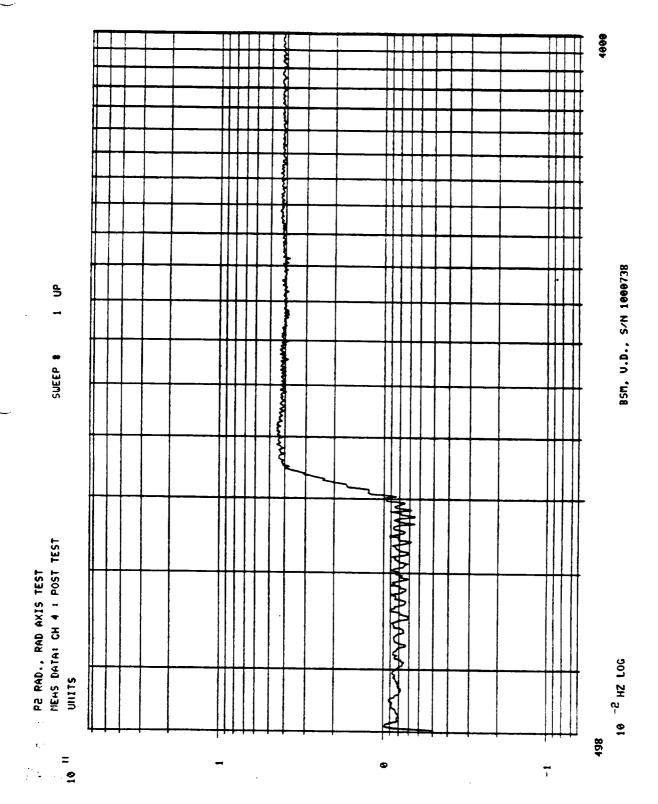




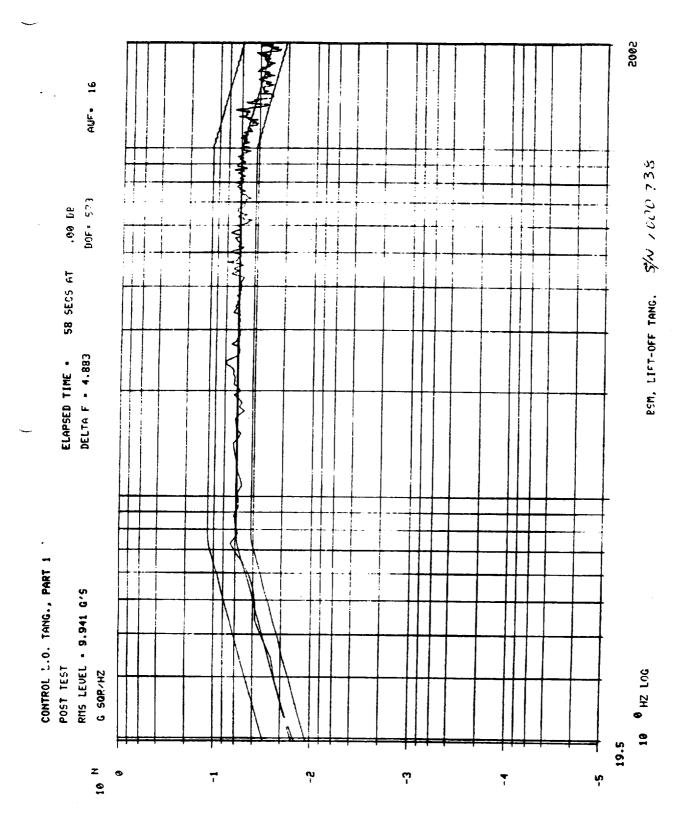


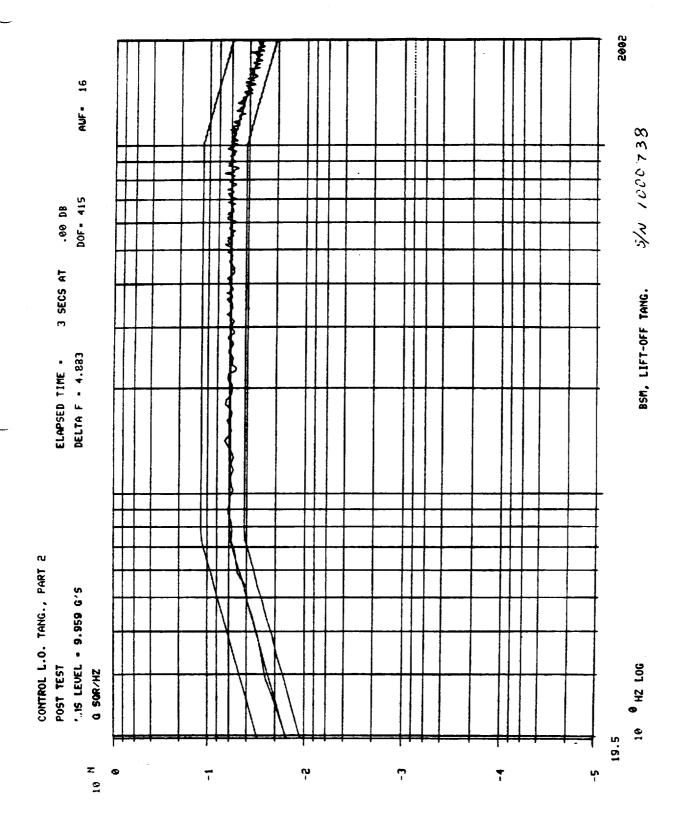






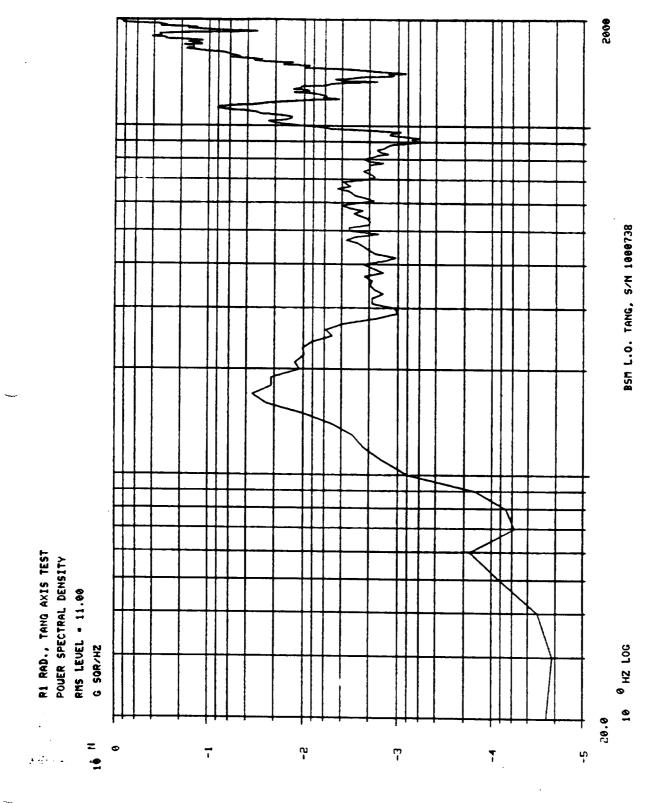
TANGENTIAL AXIS
RANDOM, LIFT-OFF



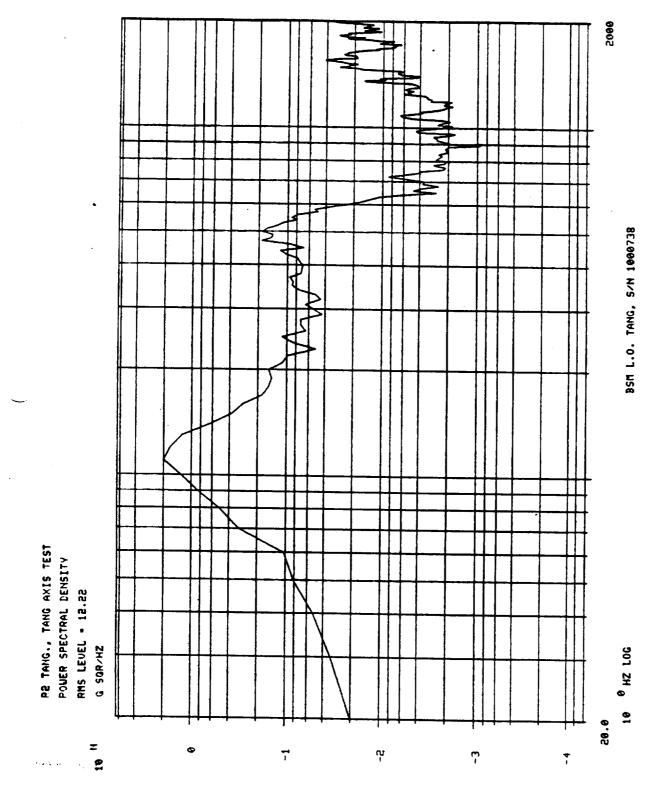


2000 BSM L.O. TANG, S/N 1000738 R1 LONG., TANG AXIS TEST POWER SPECTRAL DENSITY RMS LEVEL - 9.652 G SOR/HZ 10 0 HZ LOG 20.0 E 01 7 ហុ ۴. 5 4

2000 BSM L.O. TANG, S/N 1000738 RI TANG., TANG AXIS TEST POUER SPECTRAL DENSITY PMS LEUEL - 13.76 G SQR/HZ 10 0 HZ LOG 20.0 -0 ů 7

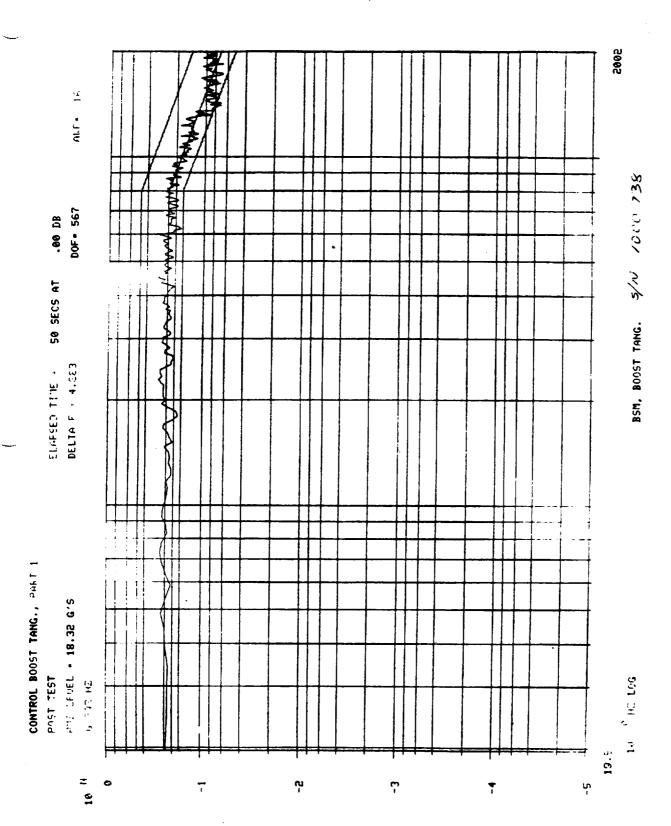


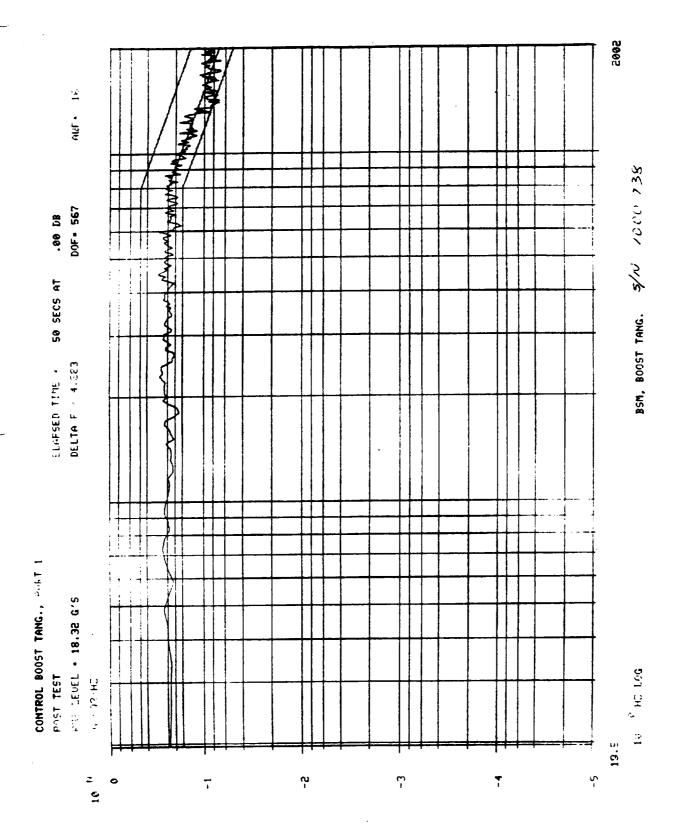
2000 BSM L.O. TANG, S/N 1000738 PE LONG., TANG AXIS TEST FOWER SPECTPAL DENSITY PMS LEVEL . 3.542 G SOR/HZ 10 0 HZ LOG = 01 7 ည ٦ 7 5

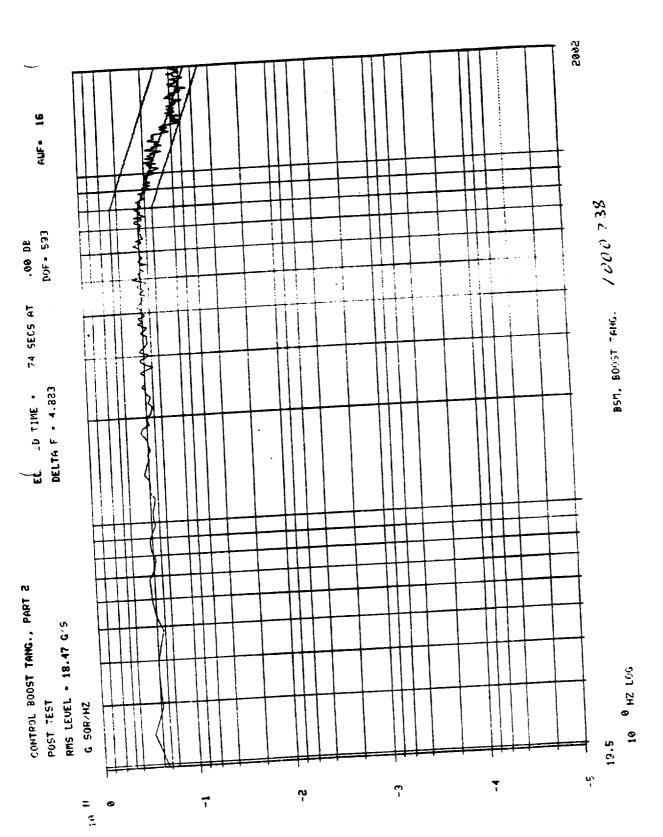


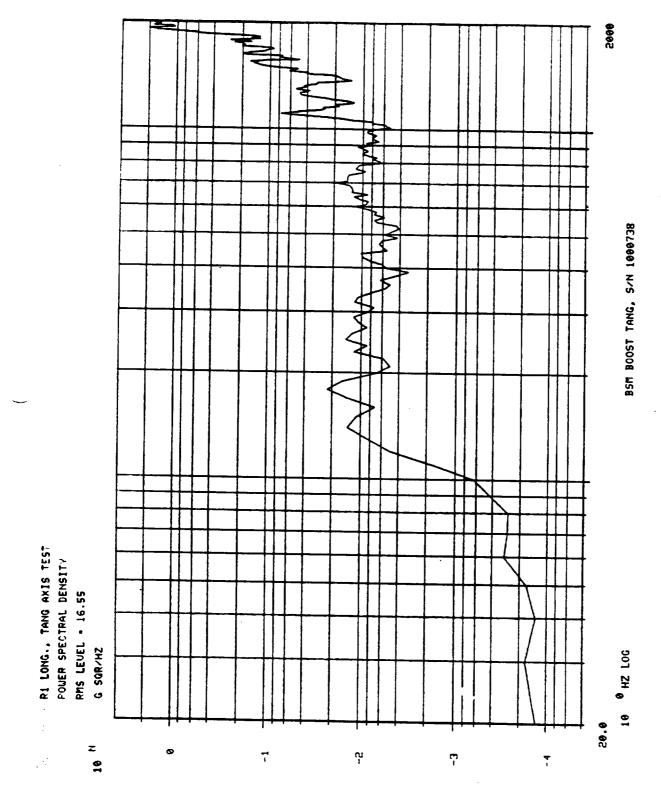
BSM L.O. TANG, S/N 1000738 PE RAD., TANG AXIS TEST FOUER SPECTRAL DENSITY PMS LEVEL = 6.138 G SOR/HZ 9 HZ LOG 10 20.0 7 ក្ Ę S Ŧ

TANGENTIAL AXIS
RANDOM, BOOST









2000 BSM BOOST TANG, S/N 1000738 RI TANG., TANG AXIS TEST POUER SPECTRAL DENSITY RMS LEVEL - 25.04 G SGR/HZ 9 HZ LOG . . . 7 q ល្អ

2000 BSM BOOST TANG, S/N 1000738 RI RAD., TANG AXIS TEST
P'LER SPECTRAL DEMSITY
RMS LEUEL • 19.38
G SQR/HZ 9 HZ 100 10 80.0 6 7 4 ç. 4

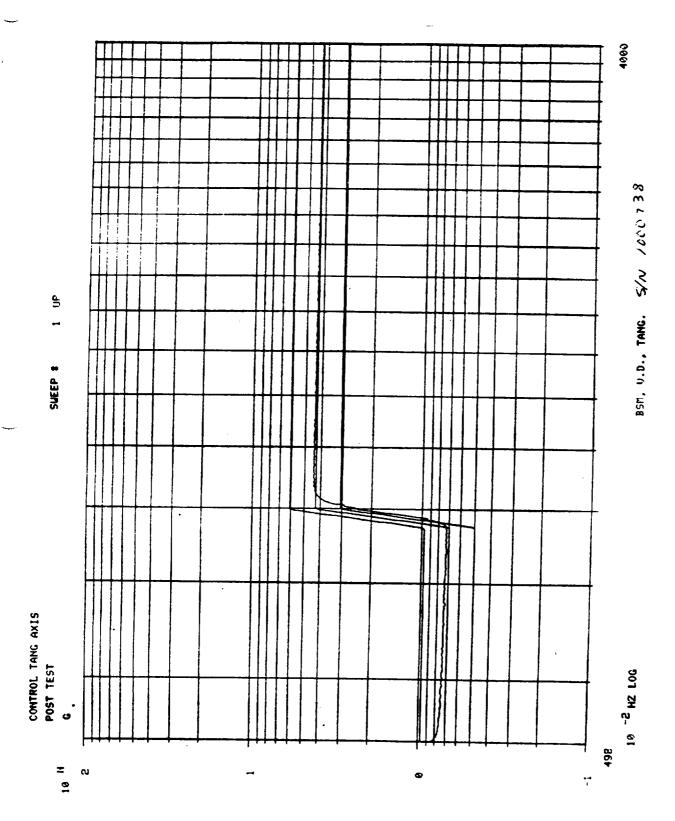
BSM BOOST TANG, S/N 1888738 PE LONG., TANG AXIS TEST POWER SPECTRAL DENSITY RMS LEUEL . 6.056 G SOR/HZ 10 0 HZ LOG ī -3 7 S

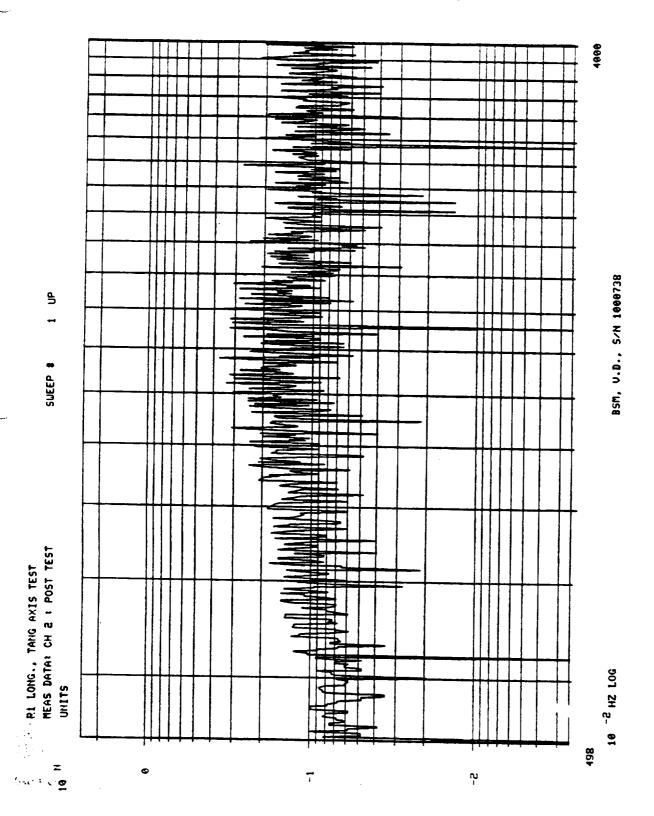
2000 BSM B005T TANG, S/N 1000738 PE TANG., TANG AXIS TEST POUER SPECTRAL DENSITY RMS LEVEL - 24.79 G SOR/HZ 9 HZ LOG င် 7 ကု

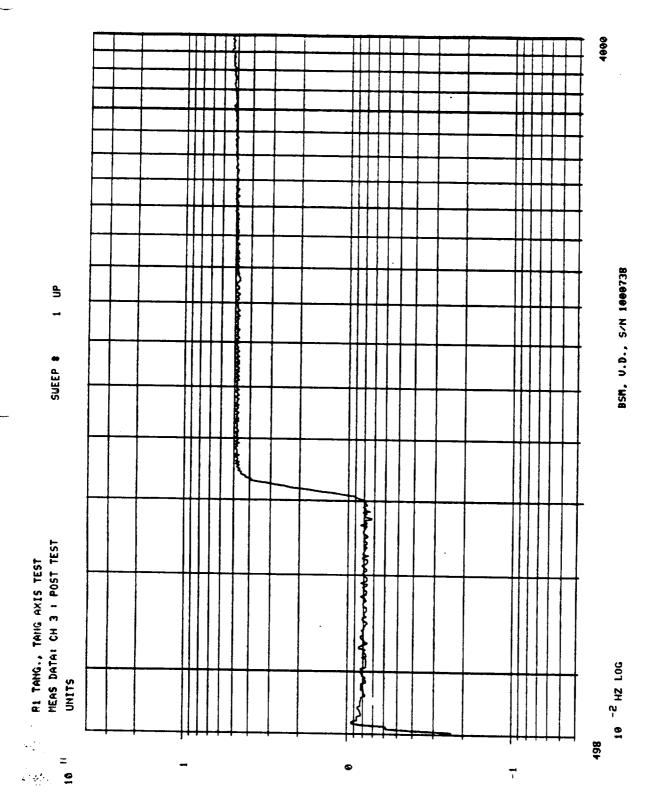
BSM B005T TANG, 5/N 1000738 PE RAD., TANG AXIS TEST FOWER SPECTRAL DENSITY RMS LEVEL • 10.48 G SQR/HZ 10 0 HZ LOG 80.0 7 កុ Ę, Ŧ

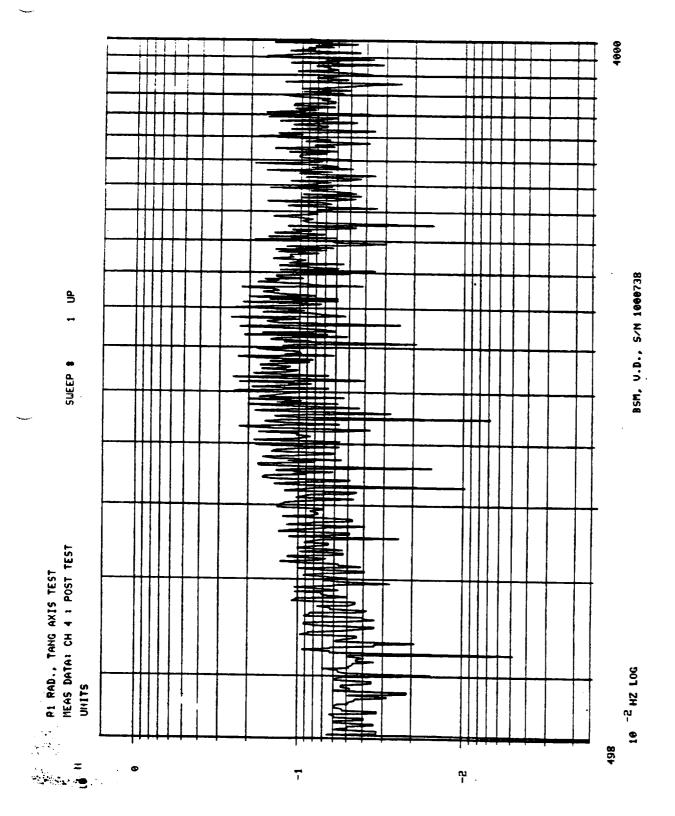
2000

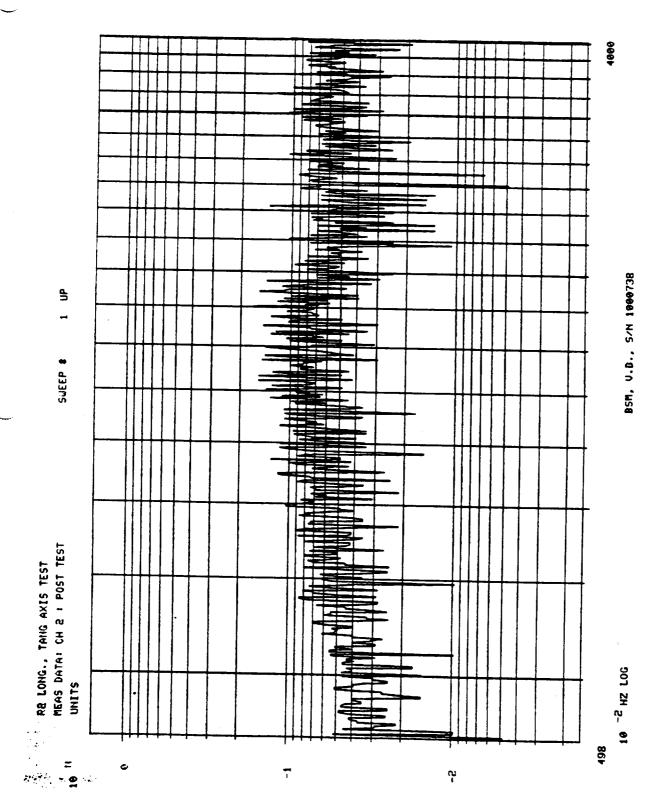
TANGENTIAL AXIS
VEHICLE DYNAMICS

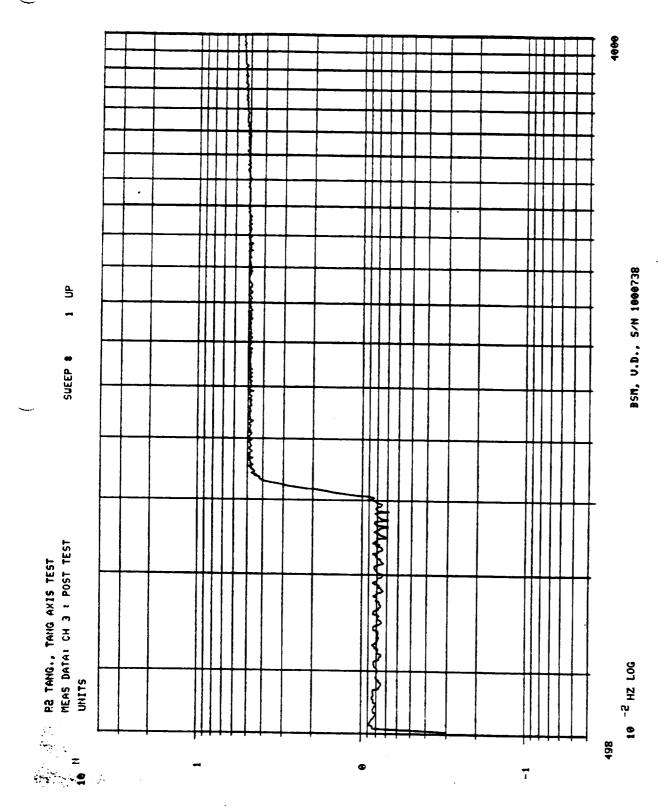


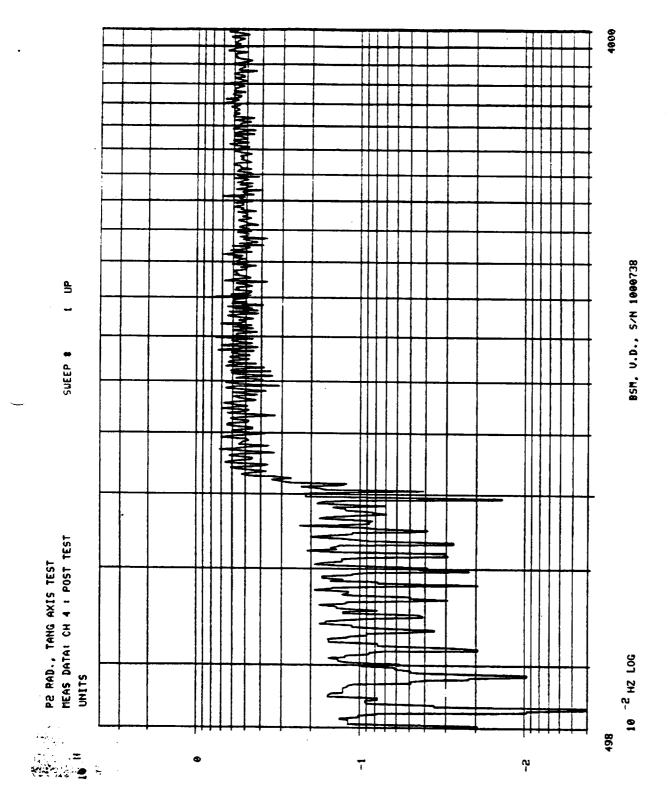




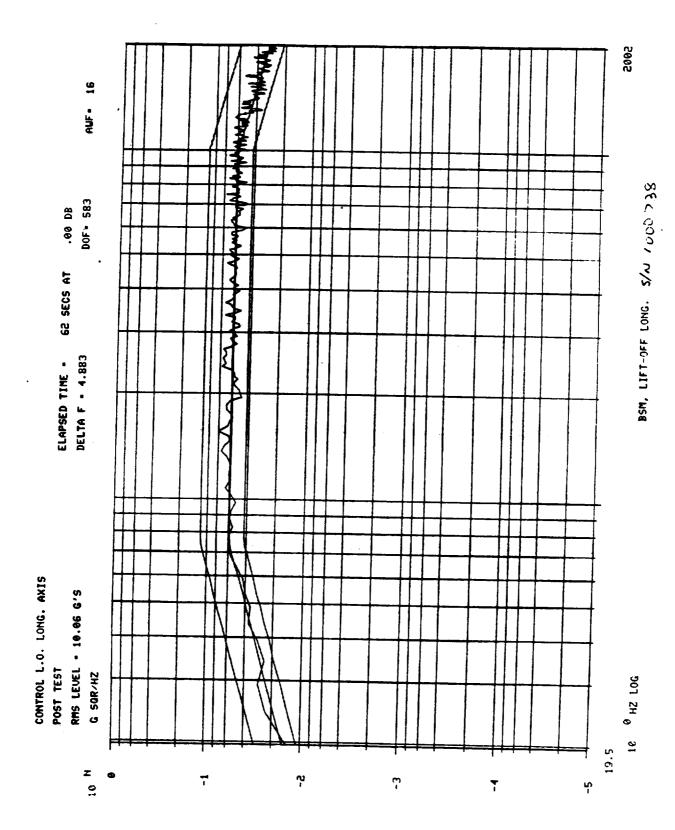


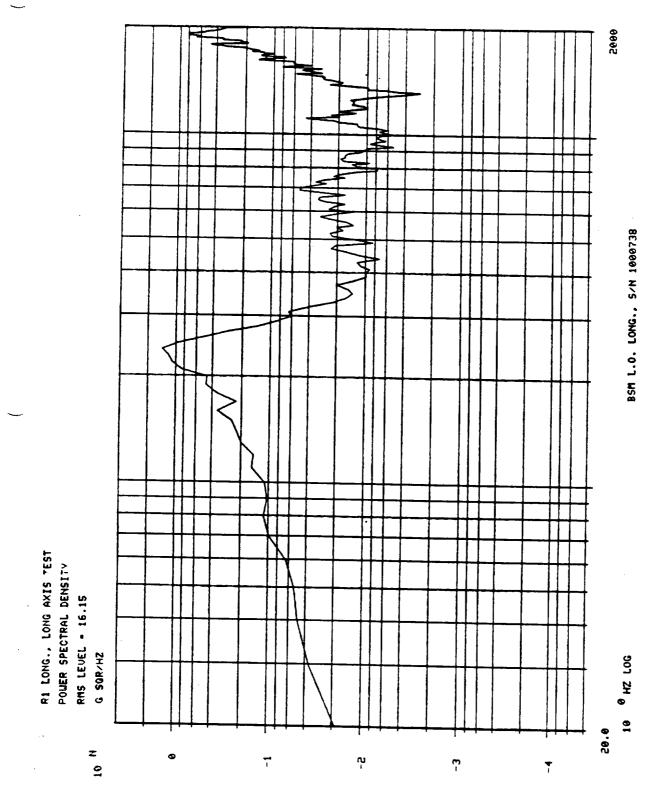


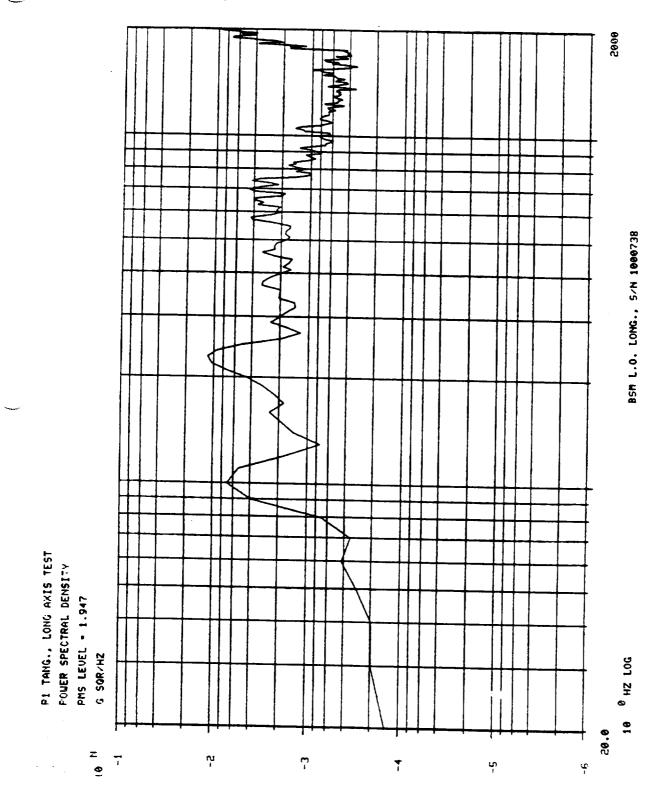


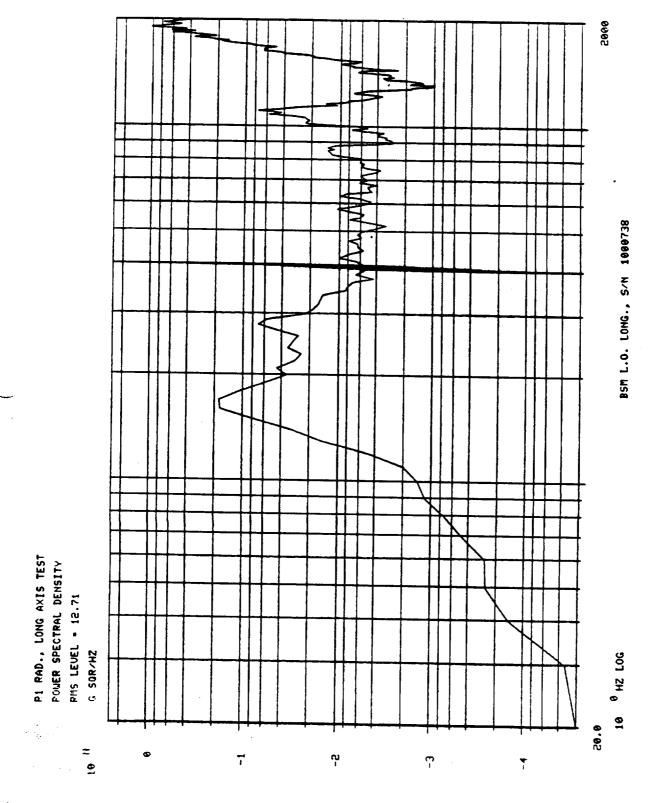


LONGITUDINAL AXIS
RANDOM, LIFT-OFF









CAUTION:

When using thread compound, personnel shall wear neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

6.2.7.5 COAT fourteen (14) screws (NAS1101E08H10) with MIL-T-83483 thread compound.

CAUTION:

When installing the Aero Heat Shield, personnel shall be extremely careful not to drop any foreign object into the rocket motor (watches, rings, and other jewelry shall be removed; eye glasses shall be tethered if worn).

6.2.7.6 With the nozzle cant vertically up, a properly grounded operator will INSTALL the aeroheat shield cover with the hinge on the left or right side when aft looking forward as specified by USBI/CSD. Proper alignment in either position is provided by a positioning pin and mating hole.

(NOTE: DO NOT lockwire the screws.)

INSTALL the 14 screws and TORQUE the fasteners using a 6.2.7.7 standard cross pattern. Record the torque values.

First Pass:

Finger Tight

MSFC QA

Second Pass: Third Pass:

10-15 in-lbs 20-25 in-lbs

Value:

MSFC QA

Fourth Pass:

20-25 in-lbs

Value: Value: _ 20.25

MSFC QA MSFC QA

Record SN of torque wrench:

framer in hiles made AHS assembly pery difficult. Priner was reincred with 1,1.1 mich and que tops

6.2.8 Make Sure the Pyro Facility Bay Doors are Open

6.2.9 Clear Area for Test

The only personnel allowed in the control room are the pyro shock test conductor, a pyro technician, the MSFC TE, and the MSFC SE (total of four (4) people). All other personnel should move to a clear area. The clear areas are defined as the NORTH hallway of building 4619 and the area outside the pyro control room on the WEST side. Other areas must be cleared with the MSFC TE and the MSFC SE.